DOCUMENT RESUME

ED 168 858 SE 026 939

AUTHOR	Ashby, W. Clark; And Others
TITLE	Our Reclamation Future: The Missing Bet on Trees.
INSTITUTION	Illinois Inst. for Environmental Quality, Chicago.
REPORT NO	IIEQ-78-04
BUREAU NO	80.057
PUB DATE	Jan 78
NOTE	109p.; Photographs may not reproduce well
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Conservation (Environment); *Conservation Education; *Environmental Education; Forestry; *Land Use; *Natural Resources; Physical Environment; Recreational Facilities; *Science Education; Wildlife Management
IDENTIFIERS	Illinois; Mining

ABSTRACT

This document discusses reclamation alternatives for land that has been surface-mined. Special attention is given to the use of tree planting as a desirable reclamation method. Contents include Illinoian reclamation history, knowledge of forestry techniques and successes on surface-mined lands, recreational and educational use of the reclaimed land, social and economic effects of reclamation, and reclamation legislation and goals. A reclamation directory containing names and addresses of coal companies, state and federal agencies, and universities and colleges is provided. (MA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED168858

ILLINOIS
INSTITUTE FOR
ENVIRONMENTAL
QUALITY

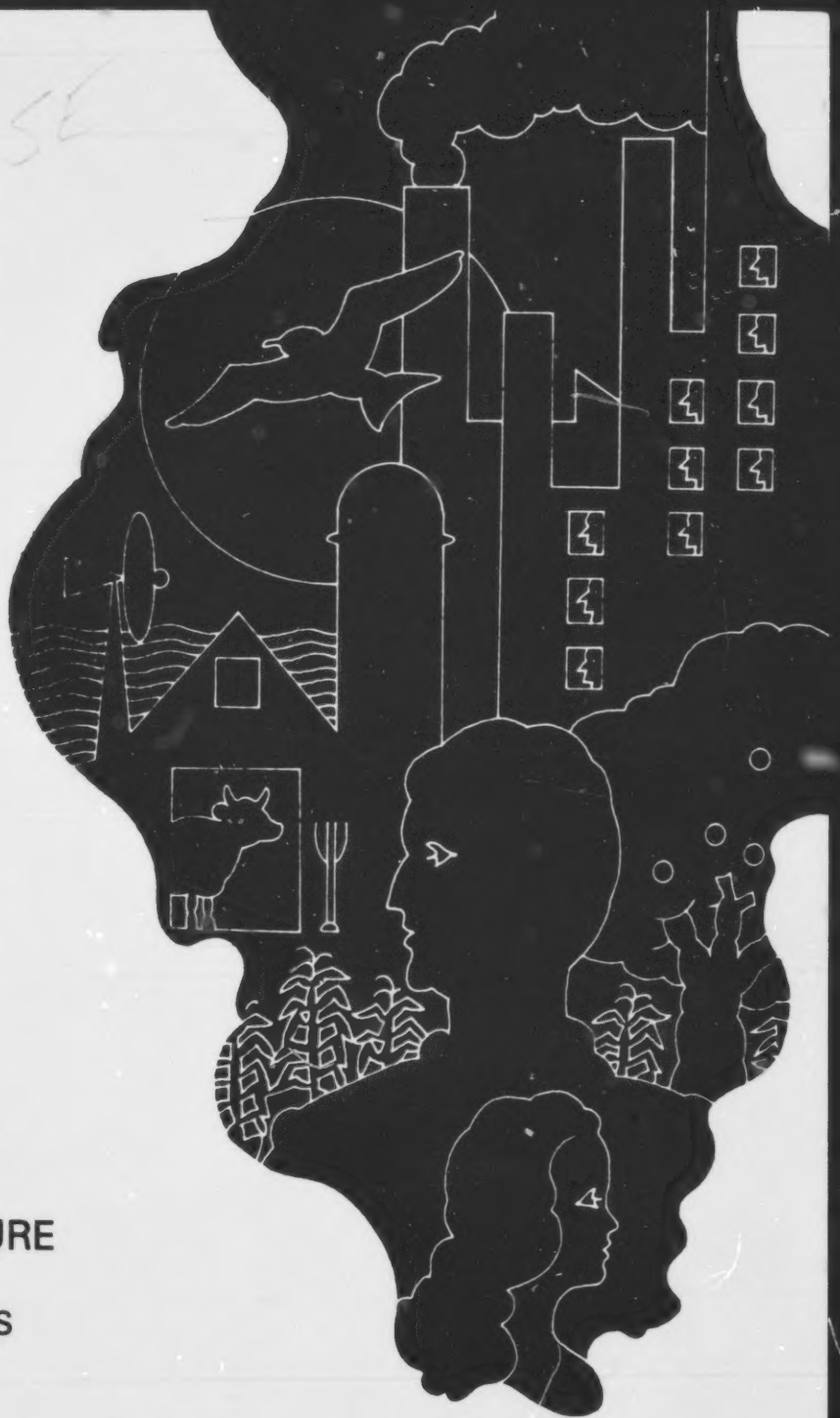
U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Eunice Choi

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."



OUR RECLAMATION FUTURE

THE MISSING BET ON TREES

SE 026 939

Document No. 78/04

Our Reclamation Future
The Missing Bet on Trees

by W. Clark Ashby
Clay Kolar
Mary L. Guerke
Christine Foote Pursell
Janet Ashby

Botany Department Southern Illinois University
Carbondale, Illinois 62901

Project No. 80.057
IIEQ Document No. 78/04

State of Illinois
Institute for Environmental Quality
Frank Beal, Director

January, 1978

NOTE

This report has been reproduced as received from the contractor. No editorial or other changes have been made. Conclusions expressed are those of the contractor.

Printed by Authority of the State of Illinois

Date Printed: January, 1978
Quantity Printed: 500

This document has been cataloged as follows:

Ashby, W. Clark, et al.
Our reclamation future, the missing bet on trees / by W. Clark Ashby, Clay Kolar, Mary L. Guerke, Christine Foote Pursell, Janet Ashby. -- Carbondale : Southern Illinois University, 1978

99 p. ; 28 cm. -- (IIEQ Doc No. 78/04)

1. Surface mining - Illinois 2. Land reclamation - Illinois 3. Coal mining - Illinois I. Title. II. Kolar, Clay III. Guerke, Mary L. IV. Pursell, Christine Foote. V. Ashby, Janet VI. Illinois Institute for Environmental Quality. VII. Southern Illinois University.

IIEQ Environmental Information Center

Illinois Institute for Environmental Quality
309 West Washington Street
Chicago, Ill. 60606
(312) 793-3870

Acknowledgments

This research was supported by funds provided by the USDA Forest Service, Northeastern Forest Experiment Station, Research Work Unit NE-1605. Funding for this bulletin was provided by the Illinois Institute for Environmental Quality. The Coal Extraction and Utilization Research Center of Southern Illinois University assisted our project in several ways.

Many of the organizations and people who made this work possible are listed in our Reclamation Directory. We are appreciative of their contributions and that of others not here listed. Louis S. Weber of the Coal Producers Association of Illinois, Don McCaw of Southwestern Illinois Coal Corporation, and Melbourne McKee of Peabody Coal Company were particularly helpful with the often frustrating problems of locating field plots and in providing reclamation history. Willis G. Vogel of the USDA Forest Service office in Berea, Ky., and David T. Funk of the Carbondale, Ill., office made possible our securing the records of early Forest Service plantings.

People who wrote sections of the booklet are listed in the first chapter. Dan Malkovich coordinated the final phases, and Gary R. Philo and Perry L. Pursell assisted in several ways. Karen A. Schmitt of the Scientific Photography and Illustration Facility prepared the figures. We are indebted to a number of colleagues who have reviewed all or selected portions of the manuscript.

C. Robert Wikel carried out a number of field plot re-surveys and the bulk of the soil chemical analyses. Charles C. Anderson, R. Scott Berg, John R. Buechner, and E. Martin O'Brien assisted in the data collection and processing. William C. Hood of the Geology Department made possible the potassium flame analyses. T. R. Peck, Department of Agronomy, University of Illinois, was most helpful with initial problems in phosphorus analysis. Richard E. Blackwelder, Department of Zoology, Southern Illinois University, generously provided the typing support in preparation of the final manuscript.

Dedicated to

Delyte W. Morris

Defender of Trees

and

Leader of Men

Contents

I.	Our reasons for writing this bulletin	1
II.	Reclamation history in Illinois	5
	Pre-law land	5
	Post-law land	11
III.	What we know about growing trees on surface-mined lands	13
	Surface-mining districts and land forms	13
	Species performance and planting recommendations	16
	Invasion of volunteer trees	24
	Black locust as a "nurse" tree	25
	Management recommendations	27
	Orchards, Christmas trees, and bee pastures	30
	Creating wildlife habitat	31
IV.	Consequences of forestation in reclamation	34
	Environmental quality	34
	Soil resource	38
V.	Recreational and educational utilization	46
	Recreation	46
	Education and interpretation	54
VI.	Social and economic effects	64
	Social impacts	64
	Economic return	72
VII.	Reclamation legislation and goals	77
	Illinois law	77
	Legal issues	82
	Reclamation goals	85
VIII.	References	87
IX.	Reclamation directory	91
X.	Common and scientific names of plants	98

I. Our Reasons for Writing this Bulletin

We share the concerns of people in Illinois and the nation that in future years surface-mined lands be aesthetically pleasing and productive. How can we best plan for the wise use of these reclaimed lands? The Illinois legislature has passed four major acts regulating surface mining for coal in the past 16 years. In 1977 the President signed into law the first federal reclamation legislation. Each act has shifted the emphasis in accordance with perceived needs at that time. The recent major emphases have been to grade to original contour, to replace surface materials, and to base post-mining land use on pre-mining use.

We believe that more consideration should be given to reclamation alternatives, and that more attention should be given to the use of tree planting in reclamation. Unlike some other parts of the nation, planting of woody plants is no longer widely practiced in Illinois and adjacent states.

We have found many reasons to recommend tree planting as a desirable reclamation alternative. Our data base is a survey we conducted in 1976 of tree plantings thirty years old on mined lands. These plantings were experimental plots established by the strip-mine research unit of the USDA Forest Service in 1947 or later in cooperation with the coal industry, plus some coal company plantings. In our survey we measured 13,236 trees on 134 plots and took 785 soil samples.

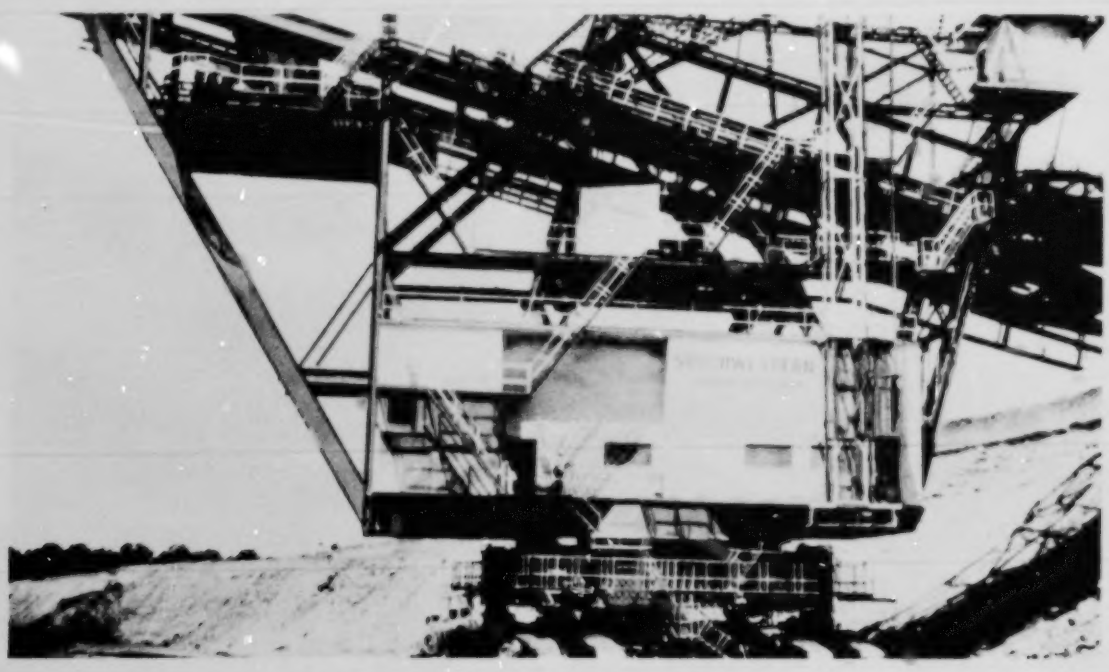


Figure 1. Mining is big business and uses big machines. How can we best plan for wise use of surface-mined land?

Figure 2. In 1947 tree planting experiments were initiated on mined lands. A forester inspects the site at time of planting. (Courtesy of USDA Forest Service)

Our survey confirmed that the success of tree planting for reclamation reported in earlier studies was sustained and enhanced over a thirty-year period. The total area presently in forest represents 18 million trees planted by the coal industry in past years, and volunteer trees such as cottonwood which come in naturally on the fresh mineral-rich spoils.

Two terms widely used in reclamation work for mined land are "pre-law" and "post-law". These apparently are not widely understood by the general public, and some people have associated pre-law with unreclaimed. By pre-law we mean prior to the first Illinois law, which was operational in 1962, and are not considering the 1943 law which was declared unconstitutional. For several years prior to World War II the mining companies in cooperation with the Illinois Division of Forestry were planting to trees each year an acreage equivalent to that mined. Interest later shifted primarily to pasture. Today under present reclamation laws, and no doubt for various other reasons, very little mined acreage is being reclaimed to trees.

The strip mines reclaimed to trees have already filled needs for housing, recreation, maintenance of environmental quality, open space, wildlife habitat, and others. Their present social and economic worth is influenced by proximity to urban areas. One great use has been to relieve the pressure on agricultural lands of demands for housing and recreation. The diverse terrain and vegetation of pre-law lands are highly attractive for these needs. Timber values will be realized in the future as the trees mature.

We recognize that tree planting will seem a more desirable reclamation alternative in some areas than in others. Areas which are timbered prior to mining, or areas with timber soils, will likely be favored. Where the reasons for reclamation to trees do apply, the knowledge of which species to grow and how to grow them is a necessary ingredient for success.

Figure 3. Thirty years later a forester evaluates tree growth at the site shown in Figure 2. (Courtesy of USDA Forest Service)

Prior to mining a reclamation plan is prepared as part of the application for a mining permit. The type of reclamation approved may be affected by past land use, the nature of the surface soils, the type of landscape with emphasis on drainage, depth of soil and rock overlying the coal seam or seams, physical and chemical properties of the overburden, and mining methods. In areas of deep, rich soil where available technology can return the surface material without permanent reduction in productivity, it should be replaced. Other areas with thin or infertile or eroded soils, such as commonly found in southern Illinois, may be enriched by mixing the surface soils with underlying soil and soil-forming minerals.

Trees grow well on soils with rock particles contributing fresh minerals and porosity to the re-created soil and with minimal grading and soil compaction. A dynamic forest ecosystem on these types of spoil hastens the development of soil organic matter, microorganisms and nitrogen levels, and leads to weathering and breakdown of rock fragments. Studies of soil development on mined lands are inadequate at present.

Flexibility in reclamation requirements to meet regional or district needs can best be administered by State regulatory agencies which, together with their advisory boards, represent the greatest available expertise. We are concerned that the emphasis on local participation in recent legislation will lead to excessively narrow reclamation goals. The best fit of resources with land use necessitates continuing research and review of reclamation success within strip-mining districts.

We examine the reclamation history in Illinois from the first voluntary work to our survey of 30-year-old plantations. The results of the tree and soil data from our survey are then incorporated in a discussion of what we know about growing trees. This discussion provides a factual basis from which further consequences of forestation in reclamation are developed. Both the scientific findings and the im-

pacts of forestation as a reclamation alternative are considered from environmental quality, recreational, educational, social, economic and other viewpoints. We present a plan for reducing the immediate massive investment in reclamation, for easing the financial burdens of impacted counties, and for building our soil resources through a soil bank program.

Our section on reclamation legislation and goals highlights the matching of scientific studies and their interpretation to guide government policies toward surface mining. The earlier reclamation legislation in Illinois is reviewed, new directions are charted, and possible changes in legislation or regulation are suggested.

The team which produced this booklet represents several disciplines. W. Clark Ashby, Professor of Botany at Southern Illinois University - Carbondale, began ecological studies of mine reclamation in 1946 in LaSalle County, while at the University of Chicago. The reclamation studies expanded greatly and resulted in a series of publications after his move to Southern Illinois University in 1960. He contributed chiefly to the sections on what we know about growing trees on surface-mined lands and on environmental quality and soil resource.

Clay Kolar, Researcher in the Botany Department, has training in biology with a concentration in wildlife ecology. His major contribution was to the sections on reclamation history and on what we know about growing trees on surface-mined lands.

Mary L. Guerke has undergraduate training in education and is a graduate student in Botany. She developed the sections on reclamation related to recreational and educational and interpretational consequences.

Christine Foote Pursell is an instructor in the Southern Illinois University School of Business and is completing her law degree. She prepared the sections on economic return and on reclamation legislation.

Janet Ashby has training in sociology and anthropology. She is presently serving in the VISTA program. Her chief contribution was the section on social impact.

Figure 4. Scenic rolling hills clothed with pine, white oak, and tulip tree a favored haunt for wildlife.

II . Reclamation History in Illinois

Pre-Law Land

Active reclamation of Illinois surface-mined lands began long before the state's first effective reclamation law in 1961. In Vermilion County, an arrangement between the Illinois Division of Forestry and a mine operator near Danville resulted in the planting of 9,000 trees in the spring of 1920 (68). The species included red pine, jack pine, Scotch pine, black locust, tulip tree, black walnut, white ash and black ash. This first planting represented the meager beginnings of an afforestation program initiated by the mining industry which eventually resulted in the planting of over 15,800,000 trees on approximately 21,000 acres of land surface mined prior to enactment of the "Open Cut Land Reclamation Act" in 1961. Orchards, recreation clubs, residential developments, youth camps, fishing areas, wildlife areas, and state parks are among the many ways pre-law lands have been utilized.

Despite the early tree planting in 1920, large-scale planting did not begin until the 1930s. The survival and growth of some species, especially black locust, black walnut, and red and Scotch pine, were sufficient to demonstrate that a cover of trees could successfully be established on surface-mined lands.

Results of the early tree programs helped initiate in 1937 a cooperative program between the Illinois Division of Forestry and six coal companies to plant 254,000 trees in the spring of 1938. Also in 1938, the Illinois Coal Strippers Association, in response to public concern over the future use of mined land, became active in reclamation. The association hired James W. Bristow to initiate and coordinate reclamation activities of the member coal companies.

Figure 5. Nearly 16 million trees were planted in Illinois alone on lands mined prior to its first effective reclamation law in 1961. (Courtesy of USDA Forest Service)

One of the early accomplishments of the Illinois Coal Strippers Association was an arrangement with the Illinois Division of Forestry in 1939 to plant with trees an acreage equal to that mined annually by the companies. This action resulted in the planting of nearly 7 million trees in the most active tree-planting period from 1941 to 1945 (Table 1). Over a million of each of the following species were planted: shortleaf pine, black locust, loblolly pine, and ash.

Table 1. The number of trees planted on Illinois surface-mined lands prior to 1969. The numbers given are in thousands. Sub-total is the number planted before the 1961 state reclamation law went into effect. Data obtained from files of Mid-West Coal Producers Institute, Inc. (Courtesy of L.S.Weber)

Species	Period of planting, 1930-1968							
	30-40	41-45	46-50	51-55	56-61	Sub-total	62-68	Total
Hardwoods								
Black locust	1,051	1,524	102	62	133	2,872	169	3,041
Ash	102	448	182	129	213	1,074	11	1,085
Soft maple (1)	212	505	117	47	41	922	62	984
Black walnut (2)	210	368	195	119	45	937	43	980
Cottonwood (3)	245	342	217	2	17	823	77	900
Sycamore	11	91	21	19	247	389	289	678
Sweet gum	9	33	43	20	225	330	266	596
Red or black oak	153	178	16	-	69	416	60	476
Tulip tree	22	87	118	48	72	347	13	360
White or bur oak	32	161	40	4	5	242	5	247
Catalpa	36	80	-	1	-	117	-	117
European alder	-	-	-	-	4	4	94	98
Osage orange	27	36	20	-	-	83	-	83
River birch	-	-	-	-	-	-	74	74
Hackberry	39	-	-	1	-	40	-	40
Red bud	-	-	-	1	-	1	17	18
Honey locust	2	-	-	3	-	5	-	5
Dogwood	-	3	-	1	-	4	-	4
Box elder	2	-	-	-	-	2	-	2
Chestnut oak	2	-	-	-	-	2	-	2
American elm	-	-	-	1	-	1	-	1
Shagbark hickory	-	-	-	1	-	1	-	1
American basswood	-	-	-	1	-	1	-	1
American beech	-	-	-	1	-	1	-	1
Butternut	-	-	-	1	-	1	-	1
Kentucky coffee tree	-	-	-	1	-	1	-	1
Mulberry	-	1	-	-	-	1	-	1
Persimmon	-	-	-	1	-	1	-	1
Wild plum	1	-	-	-	-	1	-	1
Willow	-	-	1	-	-	1	-	1
Misc. hardwoods	19	36	14	11	-	80	-	80
Time period total	2,175	3,893	1,086	475	1,071	8,700	1,180	9,880

Conifers								
Shortleaf pine	572	1,613	314	336	228	3,063	60	3,123
Loblolly pine	4	591	154	71	234	1,054	59	1,113
Jack pine	62	195	175	203	54	689	7	696
White pine	28	37	89	127	156	437	186	623
Red pine	19	134	49	219	97	518	34	552
Red cedar	-	1	-	49	208	258	165	423
Scotch pine	62	11	41	46	60	220	41	261
Virginia pine	23	103	91	14	-	231	-	231
Oriental pine	-	172	-	-	-	172	-	172
Pitch pine	9	84	62	1	13	169	-	169
Bald cypress	1	21	32	22	73	149	21	170
Ponderosa pine	-	46	-	2	-	48	-	48
Larch	2	-	-	-	-	2	-	2
Austrian pine	1	-	1	-	-	2	-	2
Misc. conifers	10	22	12	104	7	155	-	155
Time period total	793	3,030	1,020	1,194	1,130	7,167	573	7,740
Total trees planted per time period	2,968	6,923	2,106	1,669	2,201	15,867	1,753	17,620
Shrubs and vines								
Multiflora rose	-	-	13	172	76	261	23	284
Autumn olive	-	-	-	-	-	-	17	17
Bush honeysuckle	-	-	-	3	-	3	13	16
Siberian pea	-	-	-	-	-	-	7	7
Grape	-	2	-	-	-	2	-	2
Misc. shrubs & vines	-	-	-	96	-	96	-	96
Time period total	-	2	13	271	76	362	60	422

(1) Includes silver and red maple
(2) Includes establishment with both seedling and seed
(3) Includes a small number of McKee hybrid

Black locust, the early favorite, became less favored because of severe damage from the locust borer. Locust also seemed overly aggressive from root sprouts in mixed plantings. Shortleaf pine, the next favorite, also failed to meet expectations as a timber tree. Its rapid early growth was not sustained.

Several dozen species were tested over a period of forty years. Sycamore, sweet gum, white pine and eastern red cedar, plus black locust, were the main species in the later years.

With the initial success of the earlier tree plantings and the 1939 agreement between the Illinois Coal Strippers Association and the Illinois Division of Forestry, it appeared that tree planting was to be the major method of reclaiming surface-mined land. After 1945, however, both the number of trees and the acreage planted decreased dramatically. This decrease could be attributed mostly to the successful livestock grazing program started in 1938 by Byron Somers on his mined lands in Fulton County (79). The low cost and ease of seeding grasses and legumes, the quick de-

velopment of a cover crop, a demonstration to the public of the productivity of mined land, and an economic return from livestock all combined to make the creation of pastures the most desired goal in reclamation during much of the time surface mining has occurred in Illinois (Fig. 7) (28).

Although mining companies were not legally required to reclaim mined lands before 1961, most of them were very much concerned about the best methods for returning the mined land to a productive use. By the mid-1940s much of the land which had been mined was in either forest or pasture production. A great portion of this reclamation, however, was hit or miss. There were no references to guide revegetation efforts for the variety of spoil conditions found throughout the state.

Recognizing the need for better information to aid in reclamation, the Illinois Coal Strippers Association entered into agreements with the USDA Forest Service, Central States Forest Experiment Station and the University of Illinois Agricultural Experiment Station. They conducted studies to determine the woody and pasture plants most suited for revegetating mine spoils and to demonstrate potential income-producing possibilities on these lands. Their studies were conducted throughout the late 1940s and 1950s and culminated in a series of major publications which have become classics in the field of reclamation and are still in use today. These include bulletins by Limstrom and Deitschman (55), Grandt and Lang (28), Boyce and Neebe (11), and Limstrom (54).

The largest experimental planting to determine the tree species best adapted to the typical site conditions found in each Illinois surface-mine district was established in 1947. It consisted of 32 paired plots located at 16 sites in seven Illinois counties and one bordering Indiana county. In each of the 32 plots the same 17 species were planted with one species assigned randomly to a row. Approximately 50 trees per row were planted on seven-foot spacing with the rows going across the ridges and troughs.

Figure 6. Early plantings showed that sweet gum grew successfully on mined lands in southern Illinois. (Courtesy of USDA Forest Service)

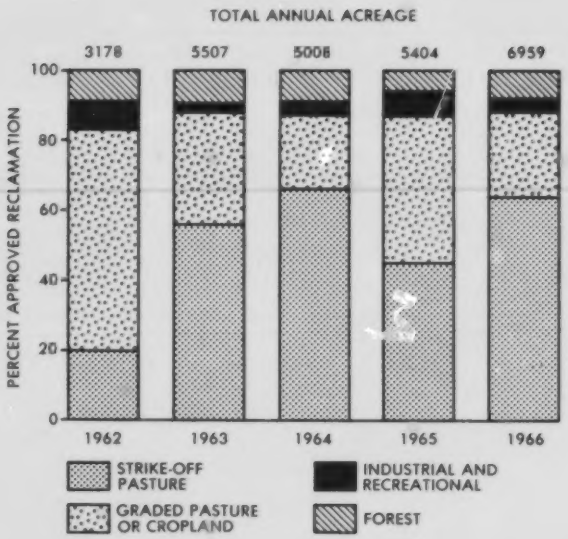
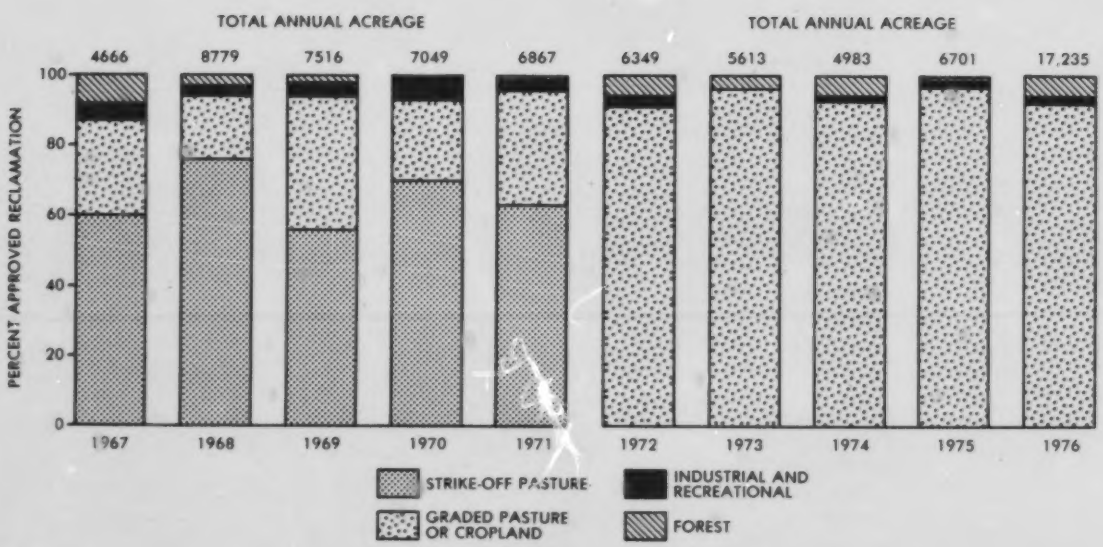


Figure 7. Percent approved reclamation for lands included in mining permits issued from 1962-1976. The numeral at the top of the bars is the total annual mine permit acreage. (35, 36, 40)



Other experimental plantings from 1947 to 1954 tested the use of black locust or shortleaf pine plantations as "nurse" crops for underplanted hardwoods and effects of ground cover on seedling establishment. Solid blocks of trees were used for a series of Christmas tree plantings.

Later in the paper we give data on forestation of planted and unplanted mines by invasion of volunteer trees. Natural invasion of trees and herbs has taken place from the earliest days of surface mining in Illinois.

In review, pre-law mined lands were reclaimed by planting trees or a variety of herbaceous species, by the successful invasion of volunteer vegetation, and by a combination of partial grading and seeding of the spoil banks. It is well to remember that the successful reclamation of most pre-law lands was a result of the foresight and work of many individuals in the coal industry, government, and universities. It has been the combined work of these and many other individuals that has helped change the face of many freshly mined "moonscape" lands into areas of rich vegetation.

Figure 8. Cooperation between coal company, government, and university groups in the late 1940s and early 1950s showed the way to successful reclamation. (Courtesy USDA Forest Service)

Post-Law Land

The term "post-law" refers to all lands surface mined after enactment of Illinois first reclamation law, the "Open Cut Land Reclamation Act", which became effective January 1, 1962. Other state laws and a new federal law have since superseded the original act. We discuss reclamation legislation and its effect on forestation as a reclamation alternative in a later section.

The post-law years have been marked by a conversion of forest to non-forest lands under the mining reclamation practices of that period. From 1972 to 1976, 20% or more of the land for which mining permits were issued was in forest (Fig. 10). Earlier figures are not available. During the same years the percent land under mining permit for reclamation to trees has varied from about one to seven percent, or a post-law average of less than five percent (Fig. 7). The total acreage presently reclaimed to trees is substantially less than the number of forested acres mined.

Figure 9. During World War II when there were few men available for planting, women near Victoria, Illinois, planted trees to reclaim strip mines. These women later organized as the Tree Planters Chapter with membership in the Izaak Walton League of America. (Courtesy of Louis S. Weber)

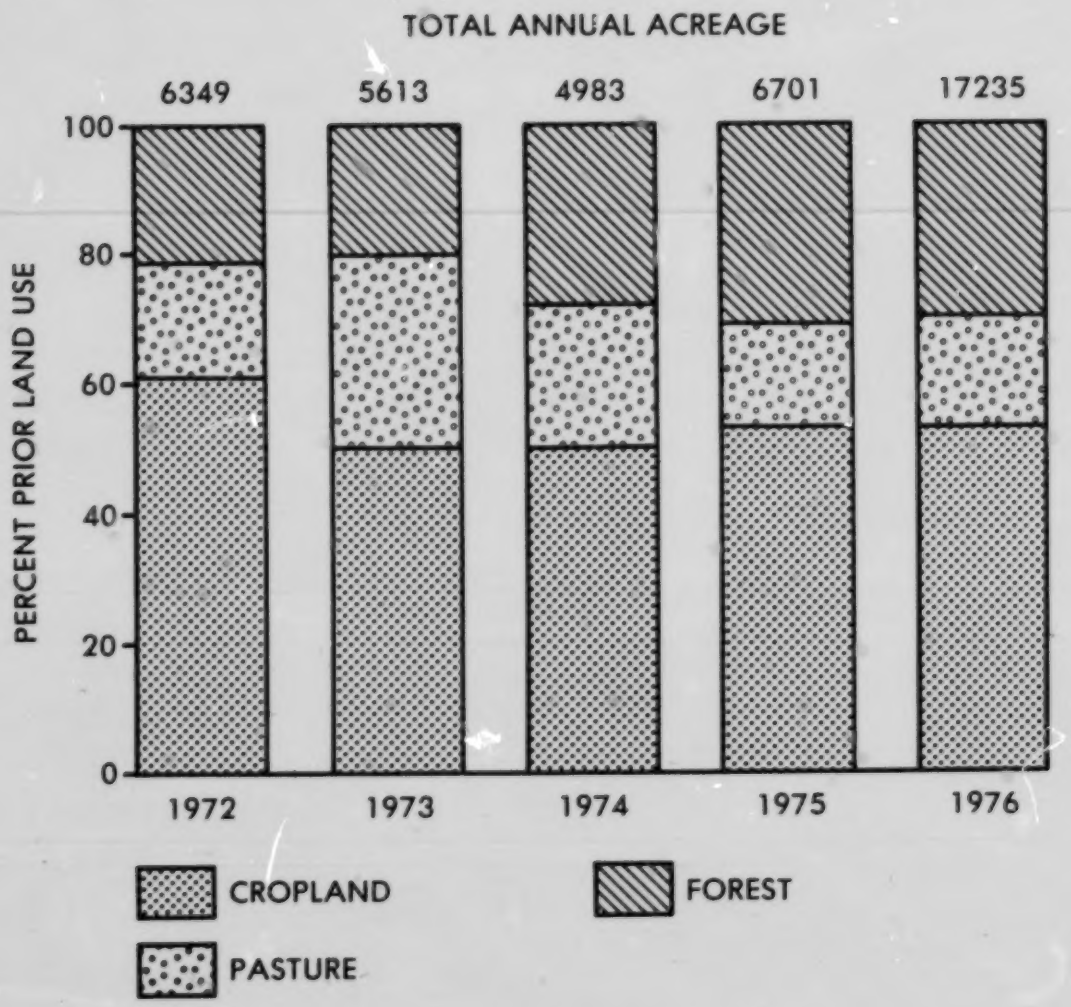


Figure 10. Prior use of lands included in mining permits issued from 1972 to 1976. The numeral at the top of each bar is the total annual mine permit acreage. (40)

Research is continuing on how best to adapt tree planting to graded lands required by recent legislation. The history of reclamation in Illinois shows tree planting as a desirable reclamation alternative. It also shows, however, that the planting of trees has decreased greatly in the past three decades.

III. What We Know about Growing Trees on Surface-Mined Land

Much of what we know came from our re-survey in 1976-77 of all USDA Forest Service experimental plots remaining in Illinois and of several earlier coal company tree plantings. We also utilized information from previous studies. Many of the original plots had been destroyed by land fills, roads, housing developments, and other uses over the past 30 years.

Surface-Mining Districts and Land Forms

An important early contribution by Limstrom and Deitschman (55) was the recognition within Illinois of five surface-mining districts (Fig. 11). District I to the northwest and Districts IV and V to the south have currently active mining, and two counties each in these districts have over 10,000 acres of mined land.

Although these districts were largely identified by the kind of overburden materials, they also represent differences in climate and in kinds of plant and animal life. Districts I, II, and III were originally chiefly prairie, with forests along rivers. In species composition these forests were southward extensions from more northern distributions.

District IV was originally predominantly forested. These forests had southern and eastern affinities. Several tree species, such as tulip tree and sweet gum, were largely restricted to this region and have not done well when planted in northern areas. The coal-mining portions of District V were originally about half prairie and half forest. Dominant tree species have both northern and southern affinities.

Overburden soils and rocks vary by district. The overburden in District I, with thick wind-deposited silts, glacial materials, and calcareous shale, results in soils high in pH. Parts of District II have similar soils. Barren older spoils, "elephant hide", in LaSalle County are high in clay and extremely acid. Extensive sandy areas are found in Will and Grundy counties. District III has shaly sandy loams and shaly clays, usually calcarous but with acid areas.

District IV has many areas in which tree growth conditions are highly favorable. Localized highly acidic, toxic and unstable banks in Williamson and Saline counties, however, have resulted in barren spoils. Proper handling of spoil materials is especially important in these counties. The older spoils in District V are typically calcareous shaly loams and clays, with localized acid conditions.

The post-mining land forms of each surface mine are determined by the kind and depth of soil and rock lying above the coal seam being mined as well as the method of overburden displacement. Irregular land forms increase land surface and thus productivity of forest or other vegetation on a unit area.

Moderate topographic diversity is advantageous for growth of many tree species. Drainage is improved and, in a sense, controlled. Water which drains from hills or ridges to the valleys or water table remains within reach of tree roots in the loosened spoil.

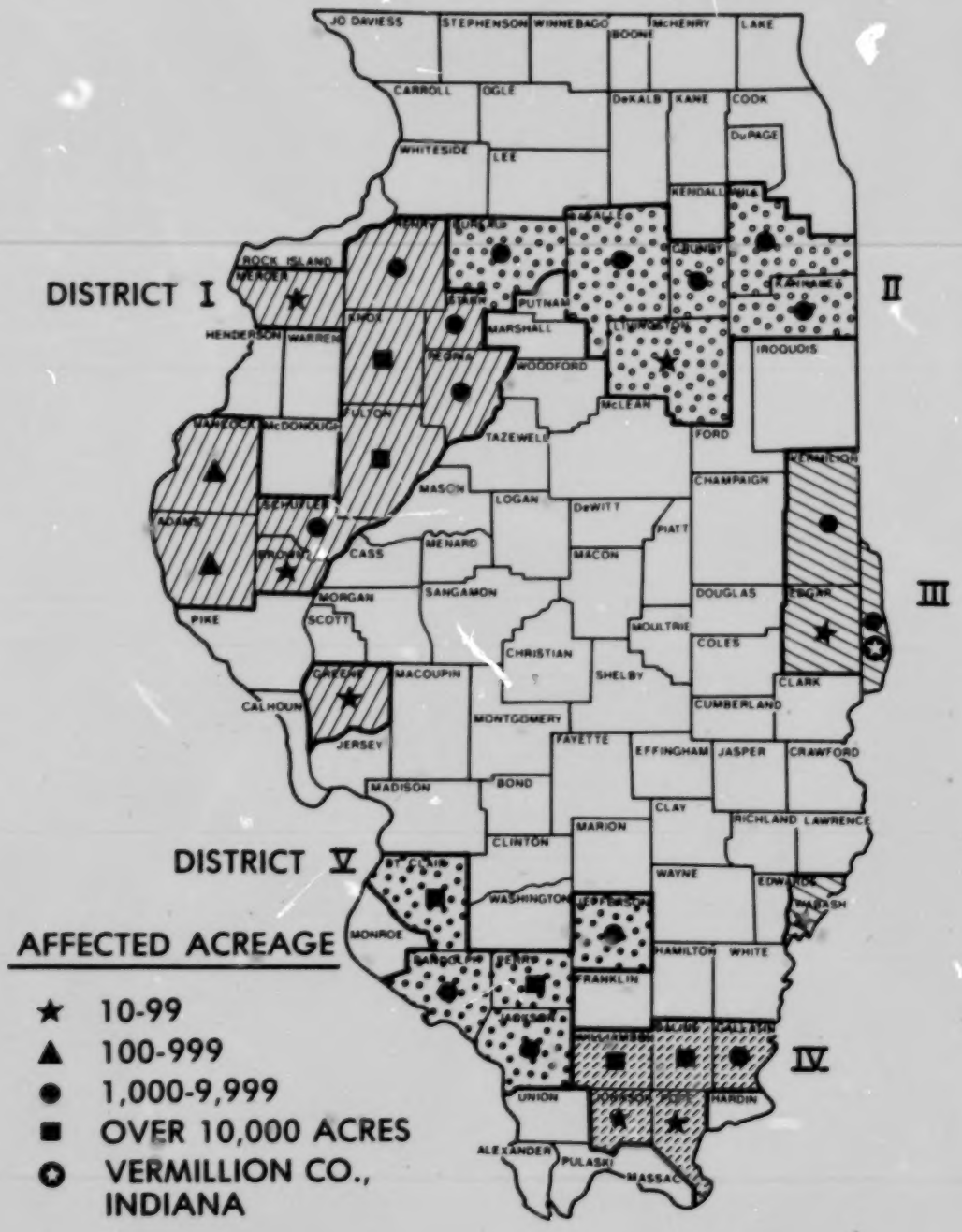


Figure 11. Five surface-mining districts of Illinois with adjacent Vermillion County, Indiana. Each district has a different combination of climate, geology, and plant and animal life. (Illinois Department of Mines and Minerals; Indiana Department of Natural Resources)

Grading has been a major feature of reclamation legislation. Whether the results are cosmetic or productive depends on future uses and care of the land. Grading may be counter-productive on new lands by compacting the spoil. Compaction lessens soil aeration necessary for root growth and water movement into and through a soil. The resulting increased runoff coupled with long slopes accelerates soil erosion and may nullify costly replacement of surface soil mandated by law.

Figure 12. Pre-law mining in District I produced scenic rolling hills, pockets of water, pasture, and forest. Figure 13. Forested surface mines in District II are popular for residential and recreational use. Figure 14. The hills and lakes of Kickapoo State Park in District III draw visitors from a large region to enjoy camping, picnicking, and boating. Figure 15. The planted pines have matured and their seedlings are filling in the unplanted borders of this mine in District IV.

Species Performance and Planting Recommendations

The growth and development of a forest plantation takes place over a period of many years. The success or failure of the planted and volunteer trees ultimately reflects the capability of the site to support and sustain tree growth. Our 1976-77 survey represents an approximate 30-year benchmark survey of plantings for which the early growth and survival are reported by Limstrom and Deitschman (55), the 10-year growth performance by Boyce and Neebe (11), and the 15-year performance of one experiment by Ashby (5).

Of all the plantings surveyed, none provide more useful information on the capability of Illinois surface-mined lands to support tree growth than the experimental plots established in 1947. This is primarily due to the design, which used the same 17 species in all the plots. The plots were distributed throughout Illinois on the variety of spoil types usually present on surface-mined sites in the state.

By 1976 most of these hardwood species and a few of the conifers exceeded 222 trees per acre, which represented a minimum survival rate of 25% (Table 2). Much of the mortality reflected early losses due to poor planting stock, rodent damage and erosion. Additional mortality as the stand developed was most apparent for the conifers, which failed to compete successfully with such native hardwoods as ash, black walnut, and silver maple. This was especially true in the three northern districts, where survival of the conifers was lowest.

Table 2. Species which had an average stand density of 222 or more trees per acre in 1976, thirty years after planting. Based on 25% minimum survival.

Species	District I	II	III	IV	V
Ash	X	X	X	X	X
Black locust	X	X	X		X
Black walnut	X		X	X	X
Black walnut seed	X		X	X	X
Cottonwood		X	X		
Osage orange			X	X	X
Sweet gum			X	X	X
Silver maple	X	X	X	X	X
Tulip tree				X	
Pine, jack			X		X
Pine, loblolly				X	X
Pine, pitch				X	
Pine, red		X		X	
Pine, shortleaf				X	
Pine, Virginia				X	X
Pine, white				X	
Red cedar	X		X	X	

The range of average diameter growth for those species with a survival rate greater than 25% is illustrated by Fig. 16. Most species which survived grew well. Black walnut, cottonwood, sweet gum, tulip tree, loblolly pine, and Virginia pine all had average diameters greater than eight inches in at least one district. Several hardwood and most conifer species grew larger in the two southern districts, IV and V. We shall discuss individual species performance later in this chapter.

In addition to the 17-row plots, several block plantings containing one, or two, planted species were also surveyed (Table 3). Although they do not survive and grow well in mixed plantings with hardwoods, the conifers had high survival rates in the block plantings.

The four pine plantings in District V represent an attempt to evaluate the potential of mined lands to produce Christmas trees successfully. Because these trees were planted with a close four foot by four foot spacing interval, the smaller growth on these plots is not unusual. Although the additional work after establishment necessary to evaluate a Christmas tree planting was never conducted, the persistence

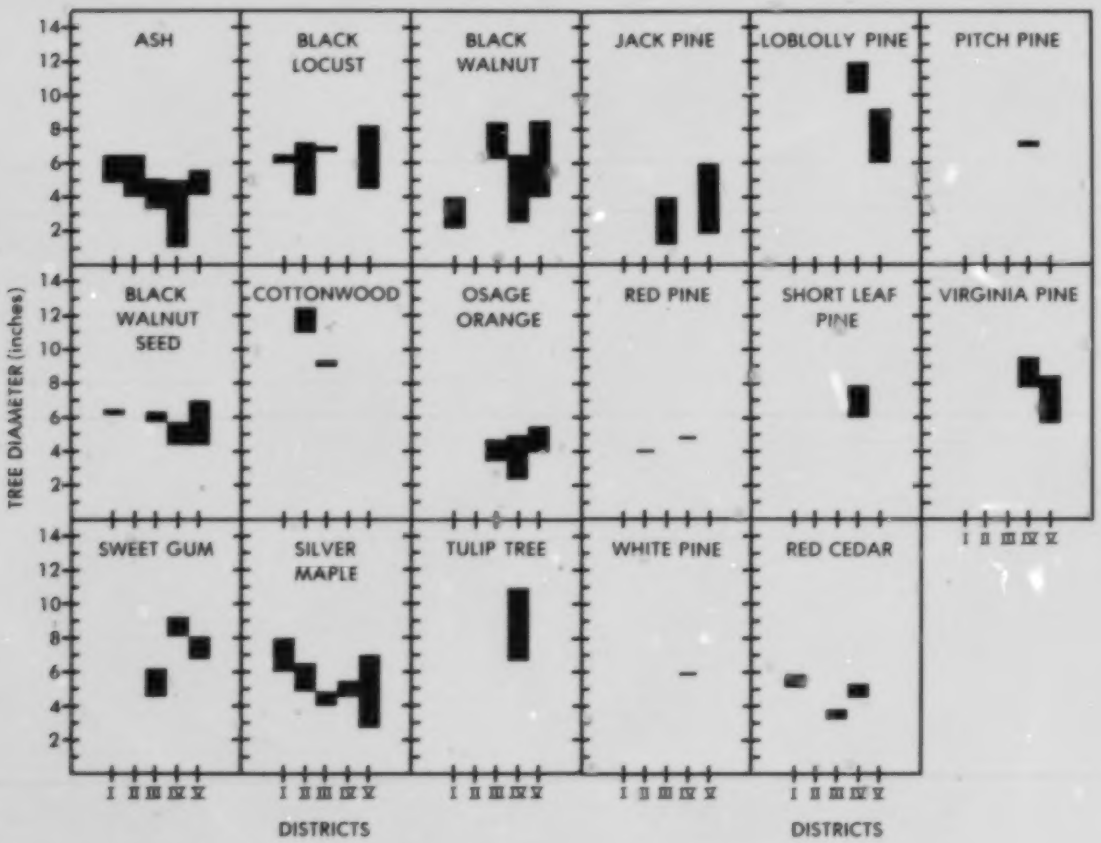


Figure 16. Tree diameter breast height 30 years after planting in each surface-mine district. Species which did not have at least 25% survival, equivalent to 222 trees per acre, in a district are omitted. The bars show the range of average diameters on the plots in each district.

of these plots indicates a potential post-mining use. Possible species would include jack pine, red pine, Scotch pine, and white pine, in addition to loblolly pine, shortleaf pine, and Virginia pine in southern Illinois.

The following recommendations are based on the cumulative tree growth performance. It is well to remember that the documented performance of these species occurs on pre-law sites, conditions which are not allowable under current reclamation regulations. Before plantings are attempted it is advisable to analyze thoroughly each potential site. The variety of lands created under the several reclamation regulations will likely support different rates of tree growth. There has been a belief that hardwood establishment is reduced on heavily graded post-law lands (17). The effects of replacing surface materials are now being studied. Until further information becomes available, we advise the forest planting practices of the Illinois Technical Forestry Association (15).

Table 3. Average diameter and age in 1976-1977 for several stands planted with one species or an equal mix of two.

Type of planting	District & species		Age (1)	Diameter (2)
Company-planted stands	I	Osage orange	Approx. 30	3.8
		Pine, jack	" 30	5.7
		Pine, red	" 30	6.1
		Pine, 50% mix	" 28	
		red		6.0 (3)
		white		6.9 (3)
	IV.	Oak, red	" 30-35	9.9
		"	" 30-35	9.6
		Oak, white	" 25	5.1 (4)
		Pine, shortleaf	" 30-35	8.1
Underplanted in black locust	IV.	Tulip tree	22	8.1
Planted for Christmas trees	V.	Pine, jack	28	4.8
		Pine, red	28	4.9
		Pine, Scotch	26	4.0
		"	28	5.4
		Red cedar	22	4.8

(1) Age in years
(2) Average diameter at breast height in inches, based on a sample of 36 trees unless otherwise indicated
(3) Average diameter based on a sample of 18
(4) Average diameter based on a sample of 47

Hardwoods

Ash - This genus had the highest survival rate. Although survival has remained consistent since the plots were established, growth of this genus, while initially good, was not exceptional. Average plot diameters ranged from less than one inch to greater than six, and average heights from 20 to over 60 feet. The good survival of this genus in all districts makes this tree desirable for mixed plantings where good initial growth and long-term high survival are the forestation goals.

Black locust - Although this species appears to have done very well, the data are somewhat misleading. Black locust is highly susceptible to damage from the locust borer. Since the species readily develops numerous trunk sprouts, the tree can maintain itself for years after being riddled by the locust borer. Even though the main trunk of the tree was not growing in diameter or height, it was measured and counted as alive. Regardless, this species will grow on nearly all types of spoils present in Illinois. It is particularly suited for screening, blocking of highwalls, as a "nurse" crop for later tree plantings, and as both a cover and food tree for wildlife. In addition, the dead trunks provide many small cavities useful to small song birds as nesting sites, and contain insects relished by woodpeckers and other similar species.

Figure 17. This 22-year-old stand of black walnut in District III was underplanted in a decadent black locust plantation. The average diameter was 8.6 inches and the average height was 77 feet. Figure 18. Black walnut was planted from seed on a spoil leveled by dragline. After 30 years the diameter was 13.2 inches.

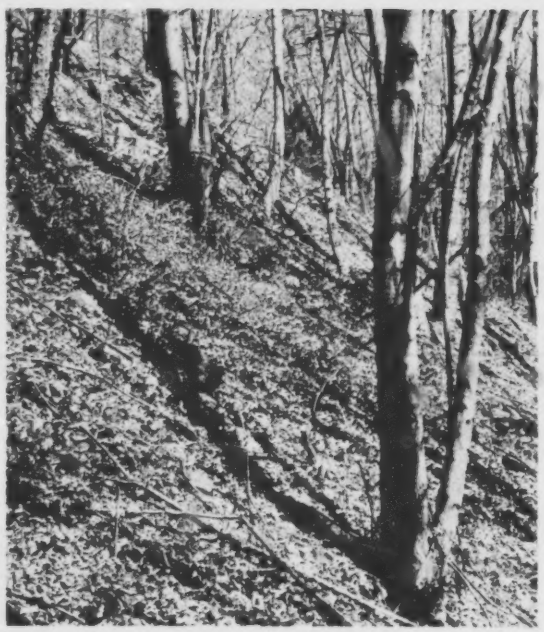


Figure 19. After 35 years red oak planted on this site in District IV had a diameter greater than 20 inches and a height greater than 70 feet. Figure 20. Silver maple had good survival and growth in all districts. In many cases trees had more than one trunk growing from the base.

Black walnut - This highly valuable hardwood was one of the most consistently performing species. While the average diameter and height were not always outstanding, after 30 growing seasons some individual trees measured over 15 inches in diameter and were taller than 70 feet. Although this species will grow in all five districts, the best sites within each district had a pH greater than 6.5, on generally well drained silty clay, sandy clay, sandy, or loam spoil types. Planting can usually be either with seed or seedling, except on sandy, unvegetated areas where seed seems to be a more reliable establishment method.

Planting in mixed stands with other hardwoods or underplanting in decadent black locust plantations also seems to help promote growth. Walnut is a slow-starting species which begins its greatest growth after the seventh and eighth year. Walnut is valuable as a lumber, nut, and wildlife tree.

Cottonwood - This hardwood was the fastest growing, largest, and most prolific early volunteer found on Illinois surface-mine sites. Overall survival of planted seedlings, likely due to poor stock, was low. Since natural invasion of cottonwood seems to stock newly mined areas better than planting, cottonwood is probably best established by this method.

Osage orange - Although initial survival of osage orange was the lowest of any species, survival rates in 1976 were very similar to those in 1949, two years after planting. Osage is adapted to most surface-mine conditions found in Illinois, but survival and growth appear to be best on the more alkaline, better drained spoils. Osage provides good cover and food for wildlife, and can be planted along edges as a screen or barrier.

Sweet gum - This southern hardwood had very poor survival in Districts I and II, but had good survival and growth in Districts III, IV, and V. It performed well on the more acid sites. The good form and lumber value of this species make it very attractive for planting on southern Illinois surface-mine sites.

Red oak - Red oak was measured at only two sites, both in District IV. Growth was exceptional for a 35-year-old stand with the largest individual having a diameter greater than 20 inches and a height greater than 80 feet. Both stands were densely stocked and located on a slightly acid spoil bank composed mostly of loess. Although this species was not observed in other districts, it is a recommended species both for pure and mixed stands throughout Illinois on better drained and slightly acid sites.

Silver maple - Silver maple is a recommended species for all surface-mine sites in Illinois. It was one of the few species which had adequate growth and survival on a site in District III having a cemented surface material. Silver maple tended to form multiple trunks at all plot locations.

Tulip tree - This species had very poor survival when planted on treeless sites except for one plot in District IV and one in District V. Growth on those plots was poor. Previous studies suggest the tulip tree can be successful when underplanted in decadent black locust plantations.

One such 22-year-old stand in District IV had an average diameter of over eight inches and an average height of over 50 feet. In District V trees on another such plot established in 1947 had good survival, diameters greater than eight inches,

Figure 21. Tulip tree grew very well in the southern districts when underplanted in decadent black locust plantations. This specimen had a diameter of 15.5 inches at 22 years. Figure 22. White oaks were not widely planted on mined lands. The good growth of these white oaks in District IV indicates their potential.

and heights greater than 60 feet. To grow tulip tree successfully on mined land the critical need is first to add nitrogen and organic matter to the site with plantings of black locust, or possibly with European alder or autumn olive.

White oak - Only one small planting of this species, located in District IV, was surveyed in 1976. The trees averaged 5.1 inches in diameter. The apparently desirable survival and growth of white oak need to be more fully evaluated.

Conifers

Red cedar - This species showed adequate growth and survival in all districts in both mixed and pure plantings. It appears suited for most mined land conditions except those sites found in District II which have either cemented or fresh, unstable, sandy surfaces. The acidity of the site does not appear to be as critical a factor as the soil surface conditions or as the presence of competing, woody vegetation. Trees at 30 years were being shaded out by both volunteer and planted hardwoods. If long-term survival and growth are desired, red cedar appears ideally suited as an edge or open-site tree for wildlife, aesthetics, noise barriers, or screen plantings. To avoid bagworm problems, however, large acreages of pure or dense stands should not be attempted.

Jack pine - Of all the pines, jack was the only one still present on plots located in each district. However, in Districts I and II survival in the 17-row plots after 30 years was extremely low. This species appears suited for most surface-mine

Figure 23. Several conifer species have good survival and growth on mined land when planted in pure stands. At this site in District IV the hardwoods have eliminated many of the conifers originally planted.

site conditions found in Illinois. It has good early survival and growth. With an open canopy in both pure and mixed plantings it should be used only in combination with the more persistent pine species if acceptable long-term survival and growth are desired. In a hardwood planting jack pine can provide cover for wildlife up to 25 years.

Loblolly pine - This southern pine was absent after two years from most plots in Districts I, II, and III. It is severely affected by cold weather and should not be considered for plantings in northern Illinois. After 10 and 30 years of growth this species was the best growing pine on the more acid sites located in Districts IV and V. Loblolly pine is suitable for acid sites in southern Illinois in both pure and mixed plantings.

Pitch pine - After 30 years pitch pine showed adequate survival and growth on acid sites in Districts IV and V. This eastern pine appeared to be severely affected by the harsher winters in the northern districts of the state. Although early survival at most of the sites was reported as good, we do not recommend this pine since it showed very poor form and is susceptible to tip moth injury. Pitch pine may have promise as a shelter tree for companion planting with more desirable hardwoods.

Figure 24. Pines planted on surface-mine lands can be used for a variety of purposes. They provide protection from wind and sun and add to the attractiveness of this home located on the top of a spoil bank.

Red pine - Two-and-ten year growth and survival for red pine were reported as good, especially in Districts I and II. After 30 years this species showed poor growth in all plots. It still had adequate survival on one plot in District II and one plot in District IV. Pure-planted red pine stands in Districts I and V after 20 years produced trees with diameters greater than six inches and heights greater than 50 feet.

Evidence of sapsucker damage was present on all red pine plots; hence it has some value for wildlife. When planted in pure stands, however, the canopy is very tight and consequently ground cover is very sparse.

Scotch pine - Plantings of this species were found only in District V in the Christmas tree plots. The trees were planted on a four foot by four foot spacing with resultant poor growth. The good 28-year survival, however, indicates that Scotch pine plantings for Christmas trees on mined lands need to be investigated more thoroughly.

Shortleaf pine - This pine responded to site conditions and locations in the same manner as loblolly pine. Shortleaf should be planted only in Districts IV and V. Although the ten-year growth was nearly equal to that of loblolly, after 30 years the survival and growth of shortleaf pine were inferior. A sampling of an approximately 30-year-old pure shortleaf pine stand in District IV showed that such stands can develop trees with diameters greater than eight inches and heights greater than 50 feet. The part of a similar stand underplanted with hardwoods died after 15 years (6).

Virginia pine - Another eastern and southern pine, this species did not survive after 30 years on plots in Districts I and II, and showed very poor survival and growth in District III. Adequate survival and growth were attained on plots in Districts IV and V, with the exception of poor survival on the most acid plot in the latter district. Virginia pine after ten years with lower branches extending to the ground had value as a wildlife cover plant. The lower branches had not persisted in 1976 and the value for wildlife was consequently reduced. Virginia pine can probably best be used for screen plantings along edges and for a period of about 15 to 20 years as a wildlife cover plant.

White pine - A northern and eastern species, this pine did not have outstanding survival or growth after 30 years on the 17-row plots located in Districts I, II, or III. White pine grew best on the most acid plot in District IV. A sampling of a mixed red and white pine plot 28-years-old in Fulton County gave average diameters of nearly seven inches and heights of over 50 feet. This species is probably more adaptable for surface-mine plantings than indicated by earlier mixed plantings with hardwoods.

Invasion of Volunteer Trees

Like begets like. Trees much more readily invade a tree-covered area than an open field. One of the major environmental consequences of planting trees is the invasion of trees, other plants found in forests, soil organisms, and wildlife.

For nearly all the plots surveyed in 1976 a large assortment of volunteer trees was present. The number and kinds of invaders were greater in areas planted with a variety of species than in areas where only one or two similar species were planted. This was especially apparent in pure pine and red oak stands where the view across the forest floor, except for the trunks of the older trees, remained unobstructed.

Table 4. For each mining district the five most frequently occurring volunteer trees in order of priority and total number of tree species.

District	Most frequent tree species					Total
I	Elm (1)	Mulberry	Ash (1)	Red cedar	Black cherry	13
II	Black cherry	Ash (1)	Dogwood (1)	Box elder	Choke cherry	16
III	Cottonwood	Elm (1)	Mulberry	Red cedar	Plum (1)	13
IV	Oak (2)	Elm (1)	Sassafras	Persimmon	Sweet gum	28
V	Dogwood (1)	Elm (1)	Box elder	Shingle oak	Black oak	22

(1) Not identified to species. All elms checked were American.
(2) Apparently blackjack oak or a hybrid, perhaps of black and southern red oak.

Typically the invasion of volunteer trees onto surface-mined areas occurred in two stages: those trees appearing when the land was first mined and relatively open, and those trees appearing after a planted stand or the initial volunteers became well established (5). Species with airborne seeds such as cottonwood and sycamore are the most obvious members of the first stage. Individuals of these early invaders were usually large and formed part of the canopy on the plots surveyed. Typical species of the second stage are listed in Table 4. Most of these trees were smaller and members of the understory. It was not uncommon, however, to find scattered individuals forming part of the forest canopy.

The kind of invading trees differed in the several regions. Of the five most frequently occurring volunteer species for each district (Table 4), District IV had only elm in common with other districts. In each district a different species was most frequent. Less than half of the five leading species were tabulated for more than one district.

District IV had the largest number of different kinds of volunteer trees, many of them southern. District II in northeastern Illinois had the largest number of invading tree individuals. These data show that a favorable forest environment is quickly created after mining. Regional differences prevail despite the common factor of disturbance.

The potential economic value of volunteer species may be great. Black cherry grows rapidly. Its beautiful and sturdy wood has many uses including veneer for furniture, interior trim, and cabinetry. Other valuable volunteer species include the oaks, ash, persimmon, sassafras, and red cedar.

Black Locust as a "Nurse" Tree

Much controversy has surrounded the use of black locust for surface-mine tree plantings. In early years it was the most frequently planted tree, due primarily to its fast growth on almost all sites and also to its nitrogen-fixing capability. When it became apparent that the locust borer would probably damage most locust plantations before they could be harvested for fence posts, planting was severely curtailed.

The fast early growth also came to be considered counter-productive. In many cases the black locust trees were planted with other trees to increase their growth. The locust were soon taller than the more desirable species planted with them. This competition would eliminate many species.

Another bad characteristic of locust, that of sending up many trunk and root sprouts, tended to make areas very dense and inaccessible. If the canopy of a locust plantation was open, a thick, lush growth of such plants as Japanese honeysuckle often accentuated the inaccessibility.

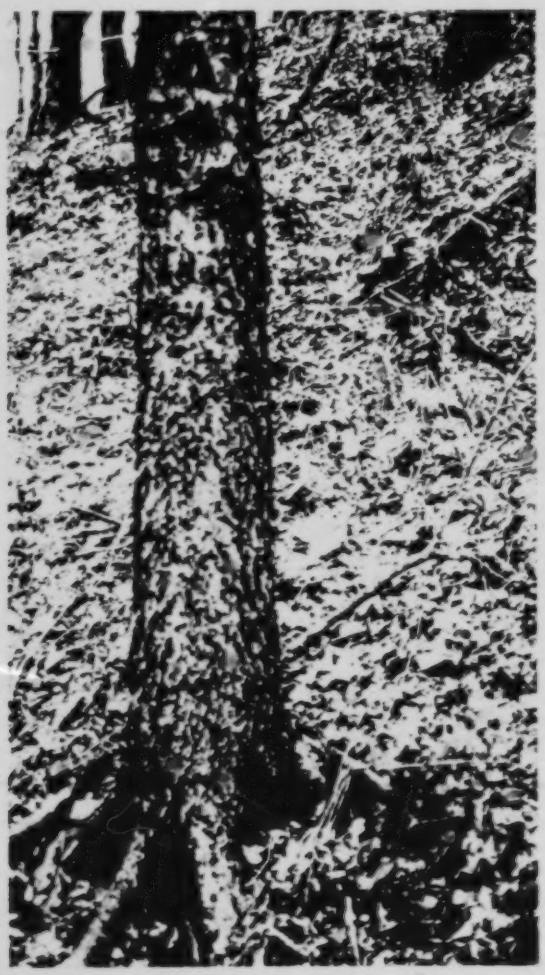


Figure 25. Volunteer trees were common in all plantations. This hackberry was in a mixed hardwood stand in Perry County. Figure 26. Black locust was planted on mixed lands to add nitrogen and organic matter. Note the dense ground cover which usually developed under black locust plantations.
(Courtesy of USDA Forest Service)

Table 5. Survival and diameter at breast height of trees 30 years after planting under a decadent black locust plantation in Perry County.

Species	Survival (%)	Diameter (Inches)
Ash	4	2.1
Black walnut	42	7.3
Black walnut seed	22	5.6
Cottonwood	0	-
Osage orange	39	3.2
Red cedar	0	-
Sweet gum	5	3.2
Silver maple	24	8.0
Tulip tree	23	8.4

Black locust has the very desirable ability to add nitrogen and organic material to the spoil material (7, 27). This helps stabilize and improve the site and increase the growth of several hardwood species.

In 1947 eight tree species were underplanted in a decadent black locust plantation. After 30 years tulip tree, silver maple, and black walnut had excellent growth in diameter (Table 5) (8). Tulip trees were planted in 1954 under a 15-year-old decadent black locust stand in Saline County (District IV). Twenty-two years later all of the black locust trees were gone and the tulip trees showed remarkable growth with several individuals having diameters over 11 inches and heights over 70 feet.

The problems of black locust, chiefly excessive competition, the tendency to form dense stands from root sprouting, and the promotion of a dense ground cover can be alleviated to a certain extent by careful management of the species. One approach would be to restrict black locust in a planting mixture to 25% or less. Certainly other innovative management tactics could be utilized. We believe the site-improving qualities of black locust warrant its inclusion in future plantings.

Management Recommendations

Species choices were discussed under planting recommendations. A forest stand, once established, can better meet the several needs for which it was planned if it is suitably managed. Considerable expertise has been developed in forest management which can be applied to the strip-mine areas. Few forested mines have been given on-going management.

A rule of very wide applicability is that forest stands, planted or volunteer, should be thinned in number as the individual trees grow larger. The lack of thinning or other management to date has limited the growth of early strip-mine plantings. It can be related to a preoccupation with other business by the ownership of the vast majority of mined acreage, coupled with the absence of any evident economic incentive to justify the expense.

Thinnings yield small trees which may have a market as pulp, posts, poles, or fuel. Especially with high-value species such as black walnut or tulip tree, a major economic incentive is the increase in value from faster growth of the remaining trees after release.

One of the precautions in thinning is that new branches may grow from the trunks of the remaining trees in a stand opened up too much. These branches will cause knots in lumber cut from a tree at harvest and degrade its value. Excessive thinning may lead to invasion of the openings by new growth, which reduces the ability of the released trees to respond to thinning.

In many areas the existing tree cover of low-value species could profitably be reduced and high-value species planted. The earlier tree cover would have improved site conditions through soil development, erosion control, and cycling of nutrients.

Needed still more in some areas is restoration of barren sites. Two approaches in site improvement by forestation are to find species which can become established on these sites, or to change the sites to favor growth of desirable species.

Efforts to find species to reclaim barren mines have met with limited success. A recent promising technique is to "tailor" or inoculate tree seedling roots with a fungus before planting. Sweet gum with a fungal partner grew successfully without fertilization. Uninoculated seedlings died on the same soils. Our research group has initiated mycorrhizal studies on mined lands in Illinois.

Another technique is to search out pioneer plants on these barren spoils and increase their numbers. A modest roster of trees successful in other states awaits trial. Likely candidates at present include a hybrid pine (pitch x loblolly), pin oak, and river birch.

Two technological fixes for barren sites are to cover them with "borrowed" soil, and to add soil amendments. Lime has been used to raise the pH of barren acidic soils with success in tree establishment. Barren spoils treated with sewage sludge in the Shawnee National Forest by the USDA Forest Service, in cooperation

Figure 27. Many species grew larger planted under black locust. This row of 30-year-old black walnut trees had an average diameter greater than seven inches with the largest tree 15 inches. Figure 28. These shortleaf pine look sparsely planted. In a few years they should be thinned to prevent crowding and stunting of growth. (Courtesy of USDA Forest Service)

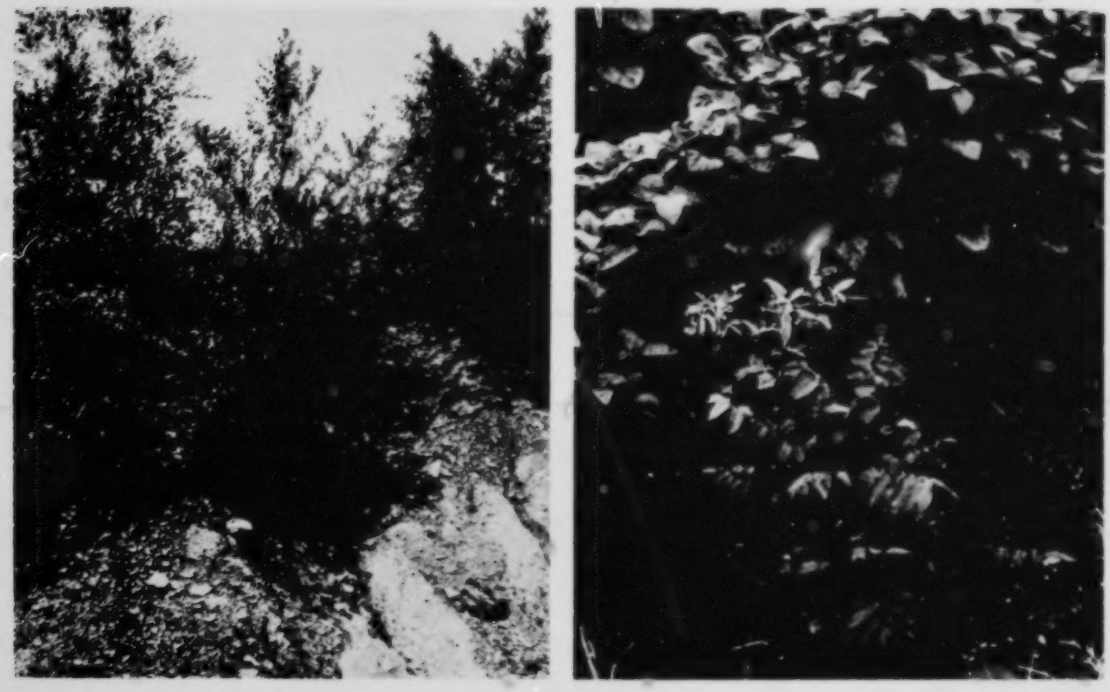


Figure 29. River birch colonized acidic spoils in District IV. Pioneer trees speed revegetation. Figure 30. The little walnut in front will over-grow the soybean rows as they enrich the soil with nitrogen and bring an early profit to the landowner. (Courtesy of H. E. Garrett)

with the Chicago Metropolitan Sanitary District, were planted to trees in 1976 by Southern Illinois University. Species successful to date include silver maple, green ash, and volunteer cottonwood.

A proposed remedy of grading barren spoils for reclamation is questionable. On problem sites grading will probably make them worse by removing the partially weathered surface and exposing more toxic spoil. The possibilities of revegetation are thus reduced, and the extremely expensive alternatives of covering with topsoil or adding massive amounts of lime and fertilizer will likely then be required.

Companion species are a technique to improve planting sites by soil improvement or as "nurse" trees. Three widely used species which have nitrogen-fixing organisms living in their roots and the accompanying desirable influences on soil enrichment include black locust, as discussed earlier, European alder, and the shrub autumn olive. The latter two have grown well in strip-mine plantings in Ohio and Indiana. European alder may compete too strongly with other trees to be generally recommended for mixed plantings. Unlike black locust, it does not experience a check on growth after early development of its stand.

Autumn olive as a shrub can be overtopped by interplanted trees. It provides good erosion control and nitrogen supply until the trees take over, and persists later as an understory. It has a tendency to spread into adjacent open lands. This will accelerate revegetation of unplanted areas.

Wide spacing of black walnut or other economically valuable trees leaves room for hay or soybean or other crops as companion plantings. As the trees mature they

spread out and use the wide spacing. By then the trees produce nut crops and, depending on the spacing, wood products from thinnings. A planting scheme of this type requires caution so that tractors and other equipment do not scar the trees. Any damage to them would result in a lower quality timber crop.

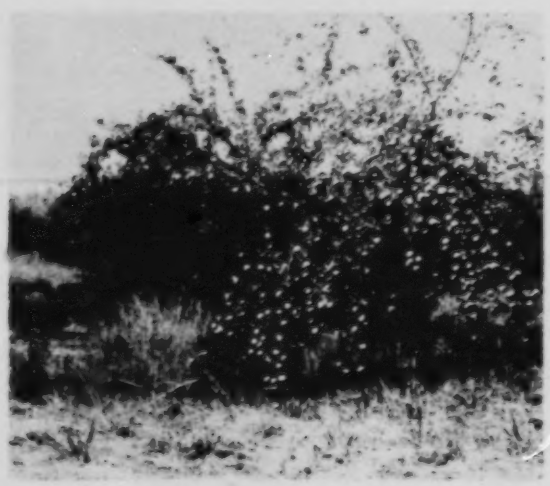
Suitable spacing in planting varies with the species selected and site conditions. It is also affected by the choice of pure planting, mixture of desirable species, or use of a companion species. Selection of planting rates is a compromise between successfully choking out competing species and limiting growth of planted species by too much self-competition. A commonly used spacing at present is 8 feet by 10 feet, or 544 trees per acre. This is fewer trees per acre than specified in some state or federal regulations for bond release. It is several times the number of canopy trees found in mature forest ready for harvest.

A higher planting rate may necessitate additional thinnings and management expense. It would help limit the number of lower branches and consequent log degrade for the harvest trees. A desirable solution where feasible is to use "nurse" trees to boost the planting rate with the expectation that these trees, or where regulations permit, shrubs, will be overtopped by the desired trees and not have to be removed in a thinning operation.

As trees increase in size they enter a grand period of growth and have maximum potential productivity during that period. On favorable sites the period of maximum productivity is much longer than on unfavorable sites. Our 30-year record of rapid growth rates on surface-mined lands supports an expectation of continued high productivity, especially if present stands are suitably managed.

Orchards, Christmas Trees, and Bee Pastures

Most orchard operations on surface-mined and other lands in Illinois have used apples and peaches. Growers have claimed that the quality of fruit was superior from



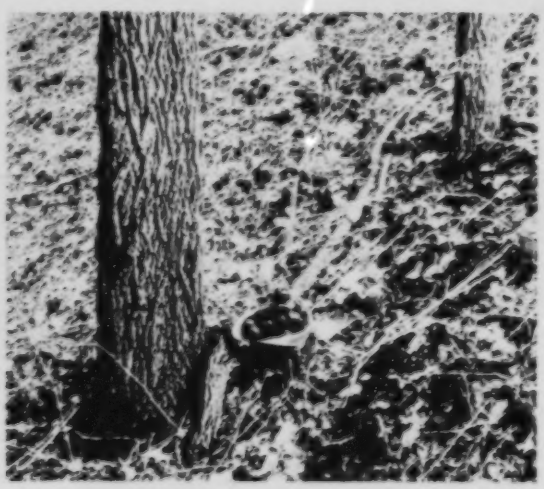


Figure 31. Apple trees nearly ready for harvest on land once harvested for coal.
Figure 32. Thirty-year-old black walnut trees planted on surface-mine sites not only grow large, but the yearly crop of nuts provides food for wildlife.

mined lands and relatively free from a disease known as fire blight. Total acreage in orchards has varied with economic conditions (70). The use of cover crops and other management practices offsets environmental problems associated with traditional monoculture systems in agriculture.

Christmas tree plantings are similar to orchards in that they bring a relatively quick economic return, are highly market oriented, require relatively intensive management, and may be carried out on a rotation of a few years.

Beekeeping has been adversely affected by changes in agricultural practices. In some areas most honey now comes from mined lands. Herbaceous species such as sweet clover are most heavily used for bee pasture. Trees may also play important roles.

In beekeeping, which produces both honey and beeswax, bees are dependent on plants for supplies of nectar, pollen, and resin. A critical factor is supply of nectar and pollen early in the spring to build colonies to maximum strength for exploitation of later nectar supplies. Peach and apple trees, black locust, and tulip tree have generous numbers of flowers relished by bees early in the season. If colony sizes are adequate, these trees also contribute to honey production. Black walnut, silver maple, European alder and other trees used on surface-mined lands also contribute to sustaining bee colonies. Strip-mine areas in forest contribute to early-season building of colonies, and those in pasture to major honey production.

Creating Wildlife Habitat

Results of the 1976 tree survey document the capability of many pre-law lands to support adequate, and in some cases superior, wildlife habitat. Planted species such as black walnut, red oak, and silver maple start mast production before 15 years. At 30 years they form canopies over 70 feet high which harbor a host of animal life.

Volunteer plants enhance the wildlife value of planted stands. Useful species include black cherry, mulberry, elm, oaks, dogwoods, persimmon, sassafras, grapes, green brier, and brambles. The essential ingredients necessary for woodland and associated wildlife are found on mined lands.

The great diversity of lands mined pre-law increases their value to wildlife. Hills, valleys and lakes fulfill habitat needs and furnish sanctuary. Isolation is especially desirable for those species relatively intolerant to human intrusion.

The large number of rocks sometimes left on a mined surface provide underground dens which are utilized by ground dwellers. Woodpeckers feed and make homes in dead black locust trees which can later be used by several species of cavity-nesting birds.

As early as 1941 researchers documented the value of mined lands for wildlife (80). Later studies showed that in numerous ways the habitat which developed on mined lands supported larger numbers of animals than nearby unmined land (48, 49, 66, 74). Klimstra emphasized that appropriate management programs could further increase the value of mined lands (50).

Pre-law lands have provided habitat for a host of nongame wildlife and such game species as deer, woodchuck, rabbit, and quail. The beaver, river otter, and giant Canada goose which reportedly had been extirpated in Illinois have taken advantage of habitat conditions existing on pre-law mined lands (39). Clean-water impoundments interspersed with well-vegetated hills become desirable habitats for these

and other wildlife. Given time and proper management the large contiguous acreages of surface mines could also support the further re-establishment in Illinois of wild turkey and ruffed grouse. Opportunities for other wildlife species seem to be limited only by the lack of appropriate management programs on the mined lands.

Lag-displacement is the immediate displacement of woodland wildlife followed by a lag in years until the tree plantings develop into a suitable forest habitat. In Illinois, where forested land is being converted at an alarming rate to highways, crop lands, reservoirs, and many other developments, the lag-displacement problem can be critical. There may not be areas from which wildlife can emigrate to restock the mined land once a forest has developed. While there are no easy solutions, mining operations could attempt to keep woodland areas unmined until the final phases of their mining begins. By developing woodland habitat on that portion of the land first mined the lag period could then be shortened.

Surface-mined lands have great potential for re-establishment of wildlife habitat in intensive agriculture areas. In the northwestern and western surface-mine districts the mined acreages offer an opportunity to develop wildlife habitat without displacing agricultural land from production.

It should be noted that many mined areas presently have little value for wildlife because planting programs have failed to consider the needs of wildlife. Habitat improvement programs have not been implemented.

Figure 33. The rolling hills and numerous ponds on pre-law land are home to many animals. Wildlife on nearby unmined lands are attracted by cover, food, and water.

Figure 34. The early-invading cottonwood is a source of food for beaver and provides nesting sites for a variety of birds. Figure 35. Mined lands produce renewable resources — plant and animal. Forest habitat supports large whitetail deer as this ambitious hunter has discovered. (Courtesy of Peabody Coal Co.)

Reclamation laws after 1971 resulted in reclaimed lands with much less topographic and vegetational diversity and a reduction in the number of water areas. This has severely limited the opportunity for creating a variety of habitat conditions suitable for wildlife. The documented positive wildlife aspects of earlier mined lands should be included in current reclamation practices (52).

IV . Consequences of Forestation in Reclamation

Environmental Quality

The quality of life for each of us is governed by our environment. Although we are most conscious of our immediate surroundings, distant landscapes affect us in unnoticed ways. Man-altered environments predominate on spaceship earth. Let us examine more closely the environmental consequences of various reclamation alternatives. These include choosing to reclaim surface-mined land to forest.

Trees as Air Filters

The healthful qualities of the air we breathe depend on plant life. Green leaves purify the air. In photosynthesis the carbon dioxide waste product of plant and animal respiration is taken up and from it oxygen is regenerated. Scientists believe that man's global destruction of forests has affected the atmosphere and may even lead to changes in climate. Forested strip mines help restore the balance of forested landscapes with a mantle of green leaves.

Strategically located forests on strip mines reduce dust loads from adjacent agricultural fields, industries, gravel roads, or continuing mining operations. Wind blowing toward and through a forest slows so that many suspended particles settle out. Smaller dust particules are adsorbed on the vast expanse of leaf, twig, and trunk surfaces.

Particulates in the air may contain potentially toxic metals such as lead, mercury, or cadmium. Unless removed by other ecosystem processes, these poisons may contaminate crops and endanger man's health. The mechanisms to remove pollutants from circulation are complex. Forests entrap contaminated dust which is washed into the soil.

The feeding activities of roots take up various potentially toxic metals along with essential nutrients. These toxic materials can be stored at low levels in their bodies without serious harm to trees, just as we can tolerate low body burdens of lead or mercury. Although the concentration of these elements is low, the huge biomass of a forest has the capacity to store large quantities.

When the trees die and decay the mineral content may be held in the humus and mineral matter of the soil for long periods. The accumulation of organic matter affects release of elements in percolating groundwaters. For example, the oxidation-reduction (redox) status of a soil is changed by additions of organic matter. Soil microorganisms which feed on the organic matter use up oxygen. Lowered soil oxygen levels affect rates of release of minerals. These processes are complex and not well understood.

We now know much more about air pollution than even a few years ago. We recognize invisible air contaminants which harm us unless removed by environmental processes. Although an immediate solution to pollution may be dilution, the so-

lution fails unless the pollutants are subsequently detoxified or removed to prevent a gradual build-up over a period of time.

Forests are damaged by ozone, sulfur dioxide, and other gaseous pollutants. At low, chronic levels this damage may not be serious. When cells in tree leaves are killed by interacting with ozone, the ozone is used up or destroyed. A way to protect our bodies from ozone damage is to enlist the help of trees. Forests have been shown to act as sinks for the removal of atmospheric sulfur dioxide (61).

Why are trees better than other kinds of plants for reducing air pollution and improving air quality? The main reason is that they are big. Air flows smoothly near the ground and over uniform surfaces such as a lawn or wheat field. A tree sticking up into the wind causes it to become turbulent. Turbulence greatly increases the mixing of polluted air with purified air under a tree canopy. This mixing speeds up the elimination of pollutants.

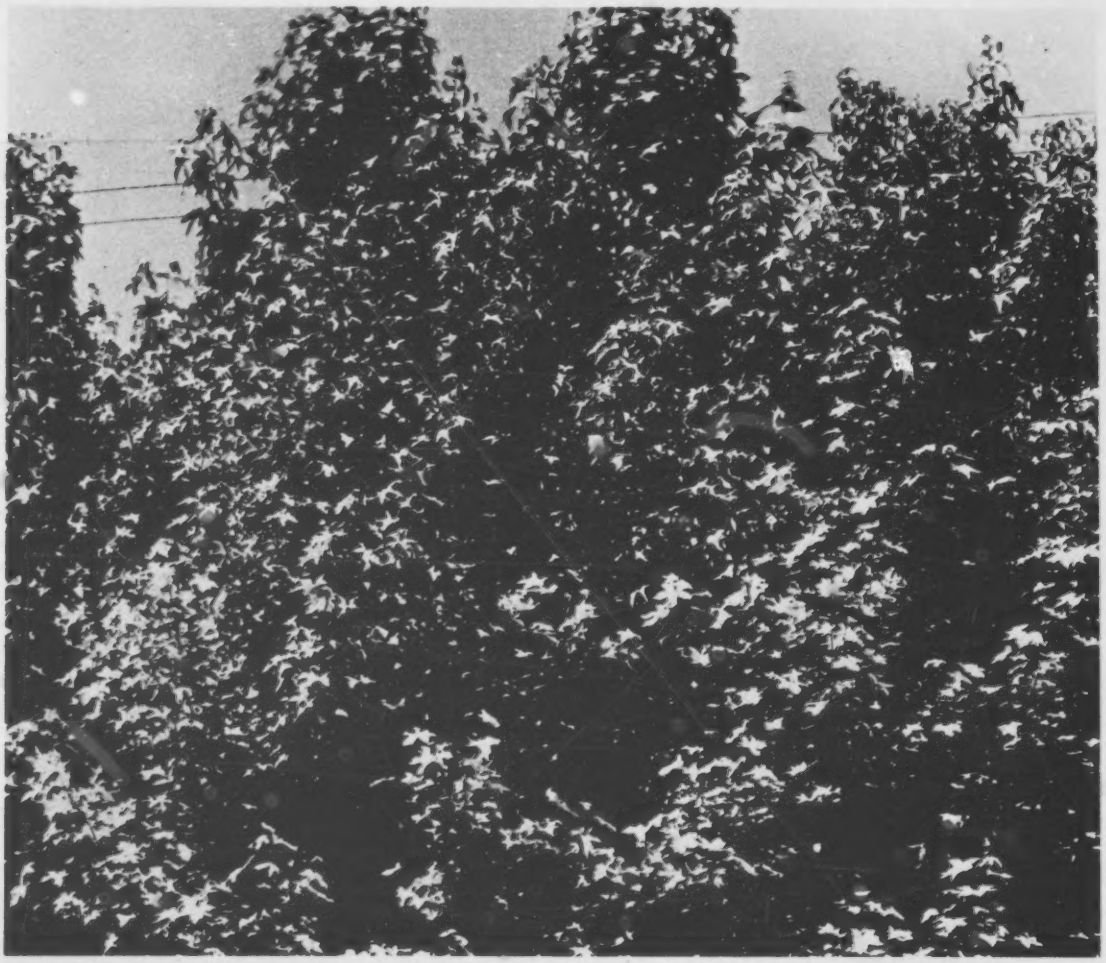


Figure 36. Young sweet gum rejuvenate the air and protect soil from erosion. (Courtesy USDA Forest Service)

Figure 37. Trees for erosion control were planted by hand on steep banks. (Courtesy of USDA Forest Service)

Trees enhance air quality throughout the year, whereas croplands are barren for many months each year. Forests are in full leaf before corn and beans are planted. Even leafless twigs in winter serve to reduce pollutant loads.

Species tolerant to air pollution should be planted where damage is experienced. Black walnut, maple, or red oak are recommended for tolerance to ozone, while ash, sycamore, and particularly white pine are intolerant.

Strip-mine plantings are important both in local areas, and as part of regional air quality management programs. The plume of affected air from the St.Louis metropolitan district which moves across two of the surface-mining districts in Illinois is attenuated by its movement across forested areas. Extensive forest planting of these mined lands would further reduce the area affected by the air pollutants from St.Louis.

Erosion Control and Water Quality

Trees eliminate or reduce wind erosion by their above ground canopies, and water erosion by their litter layer and roots. Protection, to keep the soil surface from washing, is the name of the water erosion game. The cultivated soils of Illinois agriculture, barren for much of the year, contributed 143 of the 165 million tons of soil lost to erosion in 1976. The great importance of forests in protection of streams and impoundments has long been recognized. New York City and Los Angeles both give top priority to protection of their watersheds by forests or chaparral.

Planting of strip mines to forest reduces rates of erosion. Rainwater soaks in, rather than running off and carrying away soil. Water soaks down through the soil to replenish underground aquifers. This stored water sustains stream flow and wells. Flash flooding of streams and the accompanying deterioration of water quality from sediment loads is greatly lessened.

The choice of tree species for erosion control should be based on their adaptability to the site conditions, as well as on growth form, litter production, and suitability for growing in pure or mixed stands. Mixed plantings and ground cover under trees are desirable for some species. Companion species including grasses and legumes protect the soil until a litter layer is developed.

Trees can contribute to reducing dissolved substances carried by seepage into streams and by drainage into water tables. Two mechanisms for lessening the load of dissolved materials are biotic storage in plants and long-term storage in litter and humus. Exact predictions of the change in concentration of any one element in drainage water resulting from forestation are not presently feasible.

Scenic Quality and Landscape Management

Surface-mined lands become part of a landscape. Properly managed, each landscape can give visual pleasure. For many people a changing landscape gives more pleasure than a monotonous repetition of landscape features. Strip mines clothed with trees furnish welcome variety from the unbroken plainness of present-day fields in much of Illinois, stripped of trees along fencerows and down to the water's edge along creeks.

Tree planting provides opportunities to plan in harmony with nature. Tree-covered banks of strip-mine lakes enhance the scenic values while they shade the fisherman and prevent erosion.

By choosing a diversity of trees, pine and red cedar for borders and winter greenery, oaks or walnuts for sturdy growth, sweet gum or tulip tree for autumnal color, we provide visual experiences that can bring pleasure and satisfaction to the viewer. Diversity is ecologically sound by promoting our mental well being and adding to the stability of ecosystems (75).

Mined lands often need trees for special purposes. Border areas of pre-law barren lands can be planted to trees as a screen until the whole area can be reclaimed. The tree border will then help revegetate the rest of the area by furnishing seed, shade, litter, and an improved environment for vegetation development.

Figure 38. The uncertainties of tree success on graded land are somewhat compensated by a mixture of species in modern-day machine plantings.

Figure 39. Pleasant shade, stable banks, and high-quality water enhance lakes created by mining (Courtesy of Peabody Coal Co.)

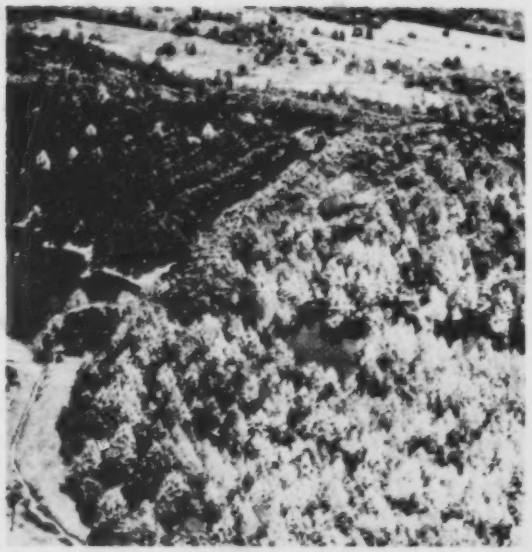


Figure 40. The forest clothes the mined land and provides scenic beauty. (Courtesy of Peabody Coal Co.)

Landscaping with trees can simultaneously serve other needs such as marshaling movement into or out of a use area, keeping people away from potentially hazardous areas, and reducing noise levels. This sort of use has been developed in a Missouri strip-mine park to separate motorbike riders from the hikers, mushroom collectors, and other users of the park.

Less immediate effects of trees on environmental quality can be extended in many ways. For example, wood has very low sulfur content. A future need for wood as a fuel can be coupled with mixing sulfur-free wood and sulfur-containing Illinois coal to meet our energy needs without harming our health or environment.

Recognition of environmental quality is now an important part of man's use of resources. What we choose to do with our land will affect us and future generations. Planting surface-mined lands to trees offers important benefits in sustaining or improving the quality of our environment.

Soil Resource

The post-mining surface serves as a rooting medium for plants. It fits the concept of soil as any substrate into which plants will root to support their growth. By this definition freshly mined overburden materials are soil.

We present two types of research findings on soil development in our tree plots 30 years after planting. One is the descriptive record from two soil pits in each plot. Data from the soil pits include field estimates to a one-foot depth of soil texture (sand, silt loam, clay loam, etc.), color, depth of darkened surface layer, amount and condition of rock particles, rooting amount and depth, and animal life. These data vary somewhat in that the color, animal life present, and other factors were influenced by moisture content and season, and by observer interpretations. Deeper cuts of mined land were examined where available.

Ten (sometimes five) surface soil samples were taken to the 6-inch depth in each plot. We carried out laboratory analyses of pH, extractable phosphorus and extractable potassium on each sample. The potassium and phosphorus analyses followed procedures used in agriculture (22, 51). A 1:2 soil to distilled water mixture was used for pH measurements with a Beckman Zeromatic SS03 pH meter.

The findings of the soil studies were that soil development had proceeded rapidly under all tree species in all geographic areas. The naming of these soils using present taxonomic units is not feasible. In newly developed soils the several soil horizons are not evident for the description of a soil profile within a soil series designation. The mined areas constitute a land type rather than a soil series.

All of the soil pits showed a litter layer, a fermentation layer formed by decomposing litter and occupied by fine feeder roots, and a humus layer recognized in the darkened surface soil. The fully darkened surface layer was usually an inch or two thick. These organic features of the mined lands were similar to those observed on naturally forested soils in Illinois.

Most stoniness had disappeared 30 years after the sedimentary rock fragments from mining were exposed to surface weathering forces. Because usage of the land on these plots which gave excellent tree growth is limited for other types of agriculture by features such as slope, and locally by stoniness, the soils would not be rated Class 1.

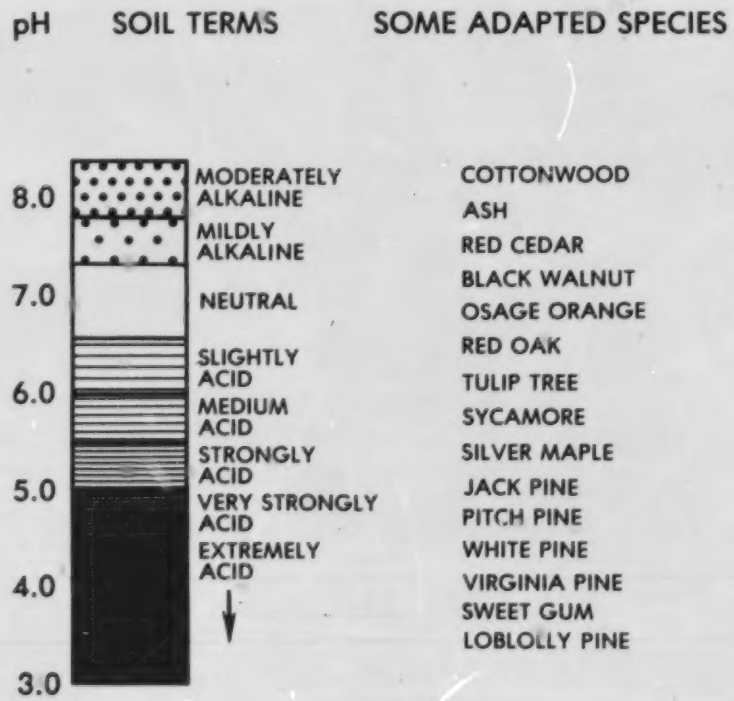


Figure 41. Species respond differently to various pH levels. Black locust, silver maple, and sweet gum are adapted to a wide pH range.

Soil pH, Phosphorus and Potassium

The unit of soil acidity and alkalinity is pH (Fig. 41). A neutral soil is pH 7, and soils at higher pH are alkaline. Medium to slightly acid (pH 5.6—6.5) soils are favorable for growth of most plants. Under agricultural conditions soils below pH 5.5 may be unfavorable for crop growth, and those below pH 4.5 typically limit growth. Because pH measurements represent a spectrum of soil conditions affecting plant growth, the interpretation of pH values as developed on agricultural soils may not be suitable for fresh mineral soils on mined lands. Mined lands with mixing of surface and subsurface materials typically differ in pH from pre-mining surfaces.

With the exception of four plots on which the surface soil pH after mining was lower than the overburden measurements, mining resulted in high, and often alkaline, pH (Fig. 42). This is shown by the diagonal stripe which represents soil pH at the time of tree planting in 1947.

The change in pH resulted from the admixture of subsurface overburden materials with surface soils in mining. Older soils in the eastern half of the United States typically are acidic from leaching losses over time of calcium, magnesium, and other soluble elements. Limestones in the surface materials after mining raise the pH as they weather. Limestones or calcareous deposits from the glacial period are common overburden materials in Illinois, although exceptions were noted in the discussion of mining districts.

Acidic conditions after mining may result from a combination of circumstances. One is the presence of sulfur in materials left on the surface. This sulfur was deposited under the same geologic conditions which resulted in high-sulfur coal. Under suitable conditions, sulfur-bearing rocks and coal fragments in the upper spoil are oxidized to produce sulfuric acid which contributes to rock weathering. If limy materials are also present in the spoil, less sulfuric acid will probably be produced, and that produced will be neutralized.

At high levels sulfuric acid will dissolve minerals in the soil to release toxic levels of aluminum or other elements as part of the overall effects of acidity. The extreme conditions of barren acidic spoils were not observed on our plots. Doubt was expressed about tree success at the time of planting in some of the establishment reports. District IV, and Jackson County in District V, have overburden materials which must be handled carefully in mining to offset potential development of extreme acidity. These areas had the lowest pH values of Fig. 42.

A further important consideration is the stability of pH within soils. Vegetation or crop programs would be difficult to administer if pH changed unpredictably with time. In general that was not the case in our plots. With two exceptions the pH did not vary more than 0.7 unit over the 30-year period after planting trees, some increasing and some decreasing. Repeated soil sampling at the time of planting could have shown pH variations of several tenths of a pH unit or greater.

The largest change in pH under the tree cover was in Grundy County on plots with sandy soil. Leaching losses are much greater from sands than from silts or clays and the change in pH from 8.2 to 6.0 on that plot may reflect a loss of calcium through leaching. The change in pH from 3.4 to 4.6 in Saline County may result from a mixture of varying proportions of acidic and alkaline materials at different locations in the plot. It could also be caused by the tree cover bringing calcium or other neutralizing materials from deep in the spoil to the surface. This beneficial action of vegetation is termed "nutrient pumping".

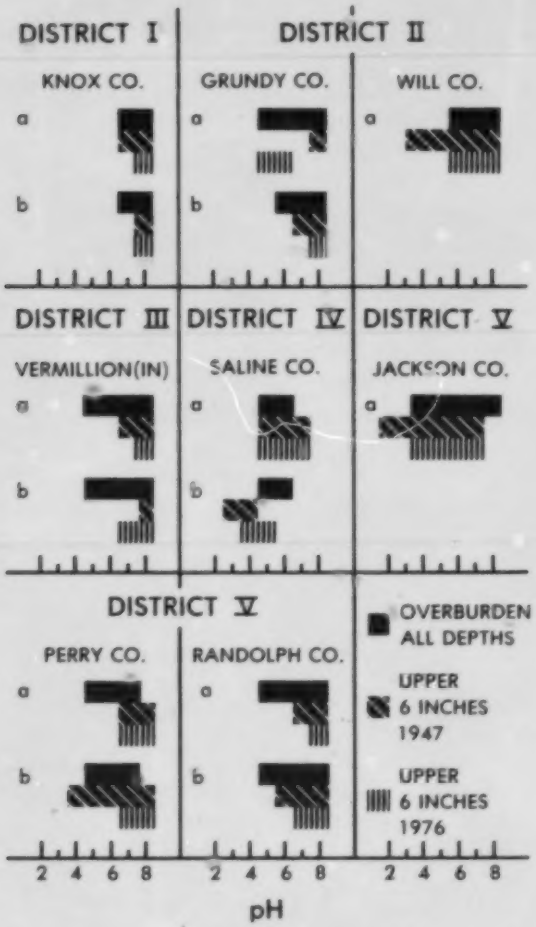


Figure 42. The record of pH from the overburden sampling to the planting of trees in 1947 and forest measurements in 1976.

Phosphorus and potassium are major plant nutrients. They are cycled from soil to plants and animals back to soil. In forest ecosystems much of the phosphorus being cycled is tied up in the plant life. Forests typically have lower exchangeable soil phosphorus levels than recommended for maximum row-crop production.

Our studies confirm these interpretations of phosphorus utilization (Fig. 43). In every instance the phosphorus levels of the soil samples under our tree plots in 1976 are lower than they were at planting in 1947. Probably because of the tight nutrient cycling we cannot see clear relationships of tree growth vigor and soil phosphorus levels. These levels are low by present crop standards except in Jackson County where some are medium.

The phosphorus levels of the several strata in the overburden become the phosphorus of the rooting medium. We do not know the amount of mixing in the mining. Reported overburden phosphorus levels in Districts III, IV, and V are as high as or higher than those of the rooting medium in 1947 at planting. In Districts I and II of northern Illinois, and one plot in District IV, analyses of the overburden did not show as much phosphorus as was present at planting.

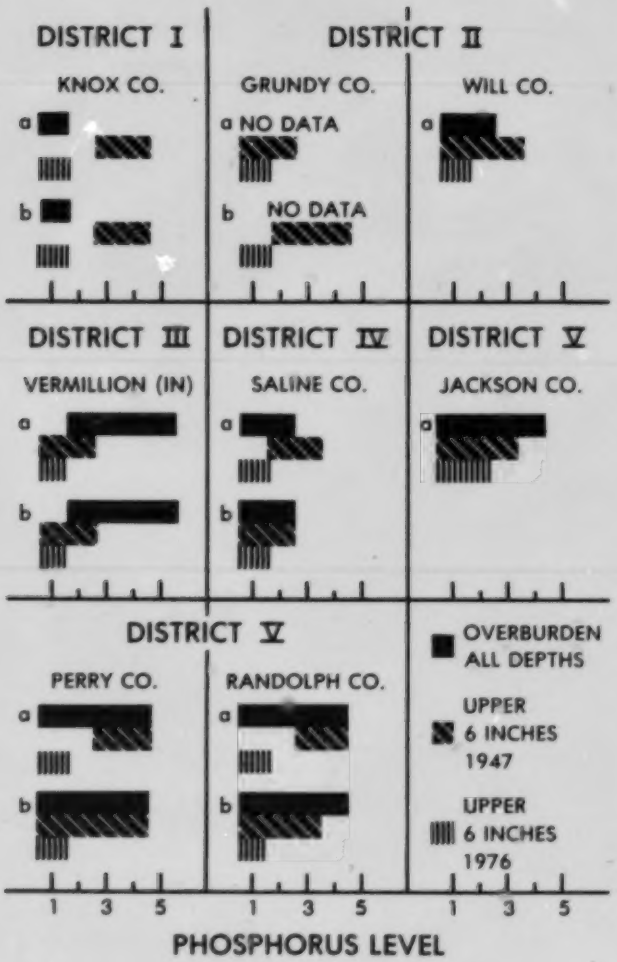


Figure 43. The record of phosphorus levels from the overburden sampling to the planting of trees in 1947 and forest measurement in 1976. Phosphorus code: 1=0-32 lb/acre, 2=33-53 lb/acre, 3=54-75 lb/acre, 4=76-91 lb/acre, 5≥92 lb/acre. (4)

Potassium is generally reported to be less limiting than phosphorus. Very high levels of potassium were reported for the overburden from all districts (Fig. 44). In District V all plots also showed very high potassium in the rooting medium at planting in 1947. The plots of other districts had medium to very high levels except in Grundy, Saline and Jackson counties which had very low values. These counties also had plots with very low values in 1976, as did Vermillion (Ind.), Perry and Randolph.

The decline in soil potassium levels from planting in 1947 to the forested ecosystems in 1976 may have been caused by a tie-up in the vegetation or by leaching. No plot had uniformly low potassium sample levels.

Tree growth and soil conditions were compared for nearby plots on mined versus unmined land in Randolph County of District V. In general the more demanding hardwoods grew better on the mined land with higher pH, phosphorus and potassium levels, and the pines better with less competition from the hardwoods on the unmined land which appeared to have been an abandoned field when planted. These plots illustrate the possibilities of reconstituting a more productive soil after mining.

Soil Bank

In evaluating the soil resource of surface-mined land the type of plant life to be grown and the time scale for making comparisons with known types of soil must be considered. Annual crops such as corn, wheat or soybeans have different growth regimes and management or cultivation requirements than permanent vegetation composed of perennial plants such as trees or pasture grasses and legumes. Nutrient relations differ in that annual crops deplete soil nutrients through cropping removal and have higher losses from erosion and leaching, especially during the months of barren ground when crops are not present or actively growing. Perennials recycle and conserve nutrients.

Nitrogen is not found in soil minerals but is biologically fixed from the air. Available nitrogen is quickly built up on non-toxic spoils (7, 27). Organic matter contributed by trees feeds microorganisms and speeds the fixing of nitrogen. Bacteria living symbiotically in the roots of legumes and other trees or herbs enhance soil nitrogen levels.

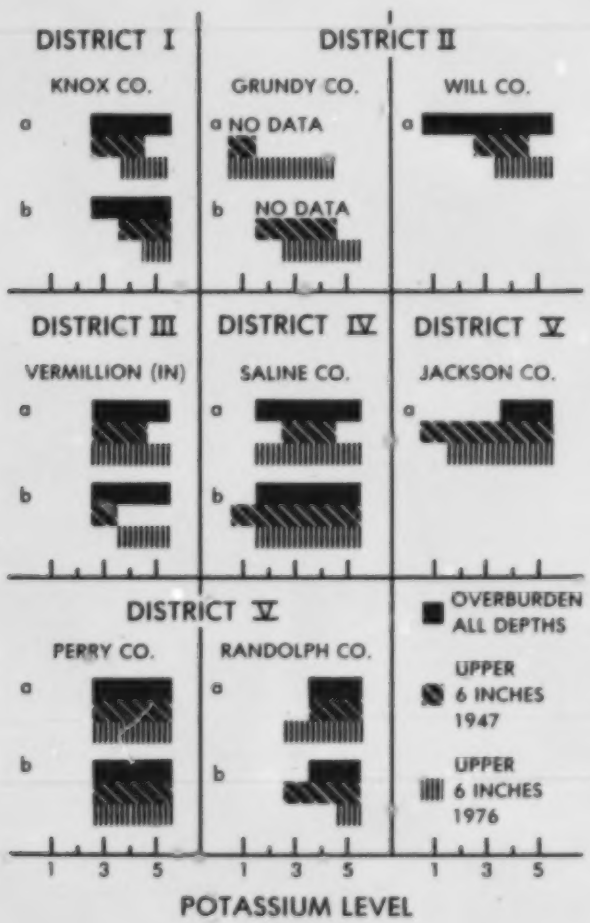


Figure 44. The record of potassium levels from the overburden sampling to the planting of trees in 1947 and forest measurement in 1976. Potassium code: 1=0-75 lb/acre, 2=76-99 lb/acre, 3=100-149 lb/acre, 4=150-200 lb/acre, 5≥201 lb/acre. (12)

Suitable drainage is a key to highly productive soils. Drainage is a multifaceted factor, because well-drained soils also are well aerated and tend not to have toxic conditions. Plants can root deeply into well-drained soils to draw on a large volume of soil for moisture and nutrients. Many pre-mining unproductive soils have a silt or clay pan which restricts drainage and limits root development. An increase in volume, or swell factor, of about 25% and mixing of overburden materials in mining lead to good porosity and drainage.

Trees and pasture plants grow well on soils with rocks up to several inches in diameter present. In Illinois rocks are generally considered undesirable in cultivated fields, perhaps more because of apprehensions about damage to equipment than concern about adverse effects on crop growth.

Another important influence on plant growth is the population of soil organisms. Heavy fertilization is required on newly mined lands. Both in the weathering of surface sedimentary rocks and the development of soil organisms, a delay of several years may greatly ease the expense of site preparation and of crop production. Relatively small surface rocks weather to sands, silts, and clays in a few years under a forest litter layer, and release plant nutrients in the process. Trees and pasture plants contribute a desirable time dimension for later cropping use.

Working with nature on a permanent type of soil development is relatively inexpensive. Leveling with a dragline and other new types of equipment does not result in the surface compaction, high erosion rates, and other problems attributed to excessive use of earth-moving equipment and bulldozers. Any final grading after mining should result in as little surface compaction as possible. During the period the mined lands are in a soil bank under trees the multiple benefits of high environmental quality, soil building, timber production, wildlife, and recreational uses can simultaneously be achieved. During this period any deep subsidence of the graded surfaces can take place to benefit an ultimate management for cultivated crops.

Figure 45. Freshly exposed rock weathers to soil with development of a forest cover in the planted areas. The overburden contains phosphorus, potassium, and other nutrients. (Courtesy of USDA Forest Service)

Figure 46. Busy ants break down the leaf litter, recycle nutrients and maintain porous soils into which rainwater soaks.

The current economic situation in row-crop agriculture and an understanding of soil development favor consideration of developing a soil bank on mined lands. At the time of tree harvest the land may be replanted to trees, or converted to other uses such as row crops or pasture. The soil bank concept may be most applicable in the counties which have the poorest endowment of deep and productive soils. These are the counties which are most favored by climate for growing trees.

V . Recreational and Educational Utilization

Recreation

Surface-mined lands are appropriate for a wide variety of recreational uses. These uses are dependent on the location and post-mining modification of the terrain as well as the type of vegetation present. If the area is wooded it is more appealing for land- and water-based activities. The presence of lakes on surface-mined lands is a primary drawing card for recreational activities. Coal mining companies with long records of reclamation programs have traditionally utilized some of their surface-mined land for recreation.

Figure 47. This site offers a sense of seclusion and tranquility for fishermen. Surface-mine lakes in the Midwest are also recognized for a bountiful catch. (Courtesy of Peabody Coal Co.)

Recreational uses are most prevalent on pre-law lands. The success of tree plantings and invasion of volunteer trees have increased the attractiveness of these lands. Fishing, boating, camping, hunting, hiking, horseback riding, and picnicking are probably the most popular activities. The rugged terrain offers a unique, primitive quality and seclusion that can seldom be found elsewhere in Illinois.

Past and Present Utilization

Roseberry (67) reported that as of 1961, before the state reclamation laws and regulations had taken effect, 14% of strip-mined land in Illinois was owned or leased by recreational organizations (Table 6). In a 1971 survey Haynes and Klimstra (32) reported that 19% of the pre-law land was utilized for recreation. This increase took place despite the loss of over 1500 acres for organized recreation in Vermilion County. The 1971 survey also shows 4% of mined lands used for unorganized recreational activities such as hunting, fishing, and swimming on privately owned lands.

By contrast, only one percent of all post-law lands was reported as used for recreation in the 1971 survey. The disparity of amounts of pre-law and post-law land devoted to recreation suggests that pre-law land forms, water resources, and vegetation are more appropriate for recreation.

Table 6. Organized recreation on surface-mined land in Illinois.

	District I	II	III	IV	V	Total
	Acres of mined land utilized for organized recreation					
1961-62 survey						
Pre-law land (a)	4207	6255	3402	41	2300	16,205
1971 survey						
Pre-law land (b)	6018	9243	1550	32	3530	20,373
Post-law land (b)	300	47	10	0	1	358
Both (b)	6318	9290	1560	32	3531	20,731
	Percent of total mined land used for organized recreation					
1961-62 survey						
Pre-law land (a)	8.9	33.9	56.5	0.0	8.2	14.3
1971 survey						
Pre-law land (b)	13.7	50.3	26.3	0.2	13.7	18.9
Post-law land (b)	1.1	1.8	0.5	0.0	0.0	0.6
Both (b)	8.7	44.2	20.0	0.1	8.1	12.3

(a) Adapted from Roseberry (67)
(b) Adapted from Haynes and Klimstra (32)

Weber (79) pointed out that a change from planting trees to pasture was initiated in 1938 when 500 acres were experimentally sown to pasture. By 1946, after World War II, the emphasis of reclamation was pastureland. Though pasture does not prohibit multiple land use, including recreation, many desirable recreational activities are more compatible with wooded lands.

Knox and Fulton counties in District I (see the district map in the section on surface-mining districts) contain several thousand acres of pre-law land owned by recreational clubs. Wee Ma Tuk Hills contains over 100 homes with recreational benefits. No post-law lands are owned by such clubs or housing developments. Public opinion, economic interests, and reclamation laws will most likely prohibit further development of recreational facilities in this agricultural region. An exception is an area in Peoria and Fulton counties where the Banner Marsh State Wildlife Area has been proposed. The Department of Conservation is in the process of acquiring 5141 mined acres for developing a freshwater marsh. The marsh will provide a major resting point for migrating ducks and geese. When the area is acquired and developed, the site will also be available for such recreational activities as hiking, camping, canoeing, bird watching, and fishing (38).

Areas mined in District II, particularly in Grundy and Will counties, are prized for their recreational value. The dense nearby urban population and lack of natural recreational areas have resulted in all available mined lands being leased or bought by groups for recreation or housing development. Further expansion of recreational lands is limited by the lack of new mining sites.

District III has the second largest percentage of pre-law acres devoted to recreation, primarily represented by Kickapoo State Park. Within the generally flat topography of central Illinois these rolling wooded mined lands in Vermilion County

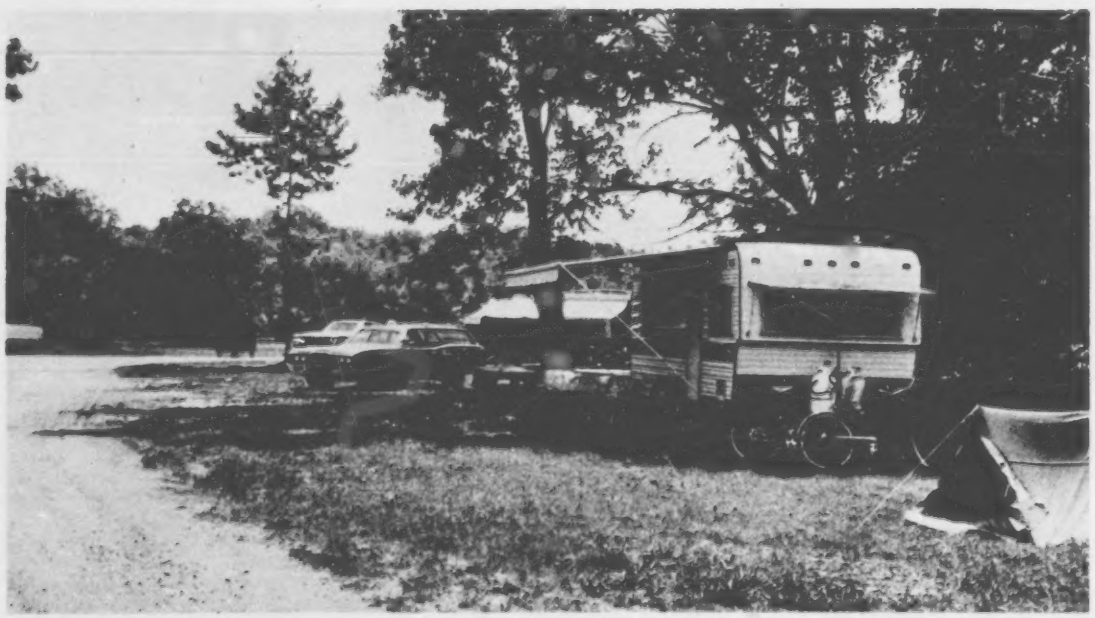


Figure 48. The Fourth of July draws campers to the Braidwood Recreation Club in Will County. Shady camp pads appear to be first choice for parking a trailer.

are unusual, providing a wealth of hunting, camping, and fishing opportunities. If these areas were absent, the people of the surrounding region would have to increase travel distance considerably to pursue such activities. It is unlikely, however, that further development of mined lands will be devoted to recreation in central Illinois with its rich agricultural land. Surface-mined land can ease the pressure for removal of land from agricultural production.

District IV, the southernmost mining region of Illinois, contains the fewest acres of surface-mined lands devoted to recreation. The largest percentage of mined land was reported as not visibly utilized (32). Within District IV lies a portion of the 250,000 acre Shawnee National Forest and the 43,000 acre Crab Orchard National Wildlife Refuge which provide outdoor recreational opportunities. In light of the present supply of recreational land and a sparse regional population, it is unlikely that large amounts of mined land will be developed for organized recreation within the district.

The DuQuoin State Fairground, Pyramid State Park, and Bill Mullins Recreational Area are all located totally or partially on surface-mined land in District V. Attendance at these areas is well over 500,000 per year (31, 37). The fairground hosts a State Fair and the Southern Illinois Arts and Crafts Fair. It is open daily for camping and in recent years has hosted several thousand people at a camper convention. Pyramid State Park provides opportunities to local and St.Louis area residents for hiking, picnicking, hunting, camping, and a rather unique horse camp. In Randolph County, Southwestern Illinois Coal Corporation provides additional recreational acres for local and area residents. The purchase of an annual permit allows holders to use company lands for hunting and fishing. St.Clair, Randolph, and Perry counties hold much potential for recreational development because of their proximity to the St.Louis metropolitan area.

Recreational Demand

Recreational need is difficult to estimate; estimates range from 25% to 8% of a region's terrain (57). Roseberry (67) suggests that a minimum of 1500 acres is required for multiple recreational facilities. It has been recommended that a recreational area contain bodies of water and land forms such as linear ridge tops and steep slopes. Such recommendations accurately describe pre-law lands which are currently being used for recreation.

The above recommendations do not reflect universal requirements but do provide guidelines for establishing organized recreation areas. Many "needs" are generated by the opportunity for their satisfaction. Recreational activities are growing faster than the population. Increases in income and leisure time allow more opportunity for recreation away from home. Future energy and transportation considerations may, however, limit recreation which involves extensive travel. Non-consumptive activities such as hiking and birdwatching are becoming as popular as consumptive activities. "Natural" outdoor recreation increases directly with income and education (47).

In Illinois the Department of Conservation has developed the concept of "transfer tolerance", which is appropriate to use in conjunction with recreational opportunities provided by forested mined land. Transfer tolerance is "based on the assumption that outdoor recreation activities are grouped according to the time persons spend or are willing to spend traveling to where they can find the type and quality of experience desired" (21).

Potential Supply of Land for Recreation Needs

By comparing a map of forested surface-mined land (Fig. 49) with maps of the large population centers of Illinois and their expanding transfer tolerance zones (Fig. 50, 51, and 52), generalizations can be made comparing demand with a potential supply.

Low transfer zones extend from large population centers with a radius determined by one-half hour of driving time. Low transfer tolerance activities include several that are compatible with forested surface-mined lands — picnicking, horseback riding, swimming, hiking, and certain types of fishing. The maps reveal that

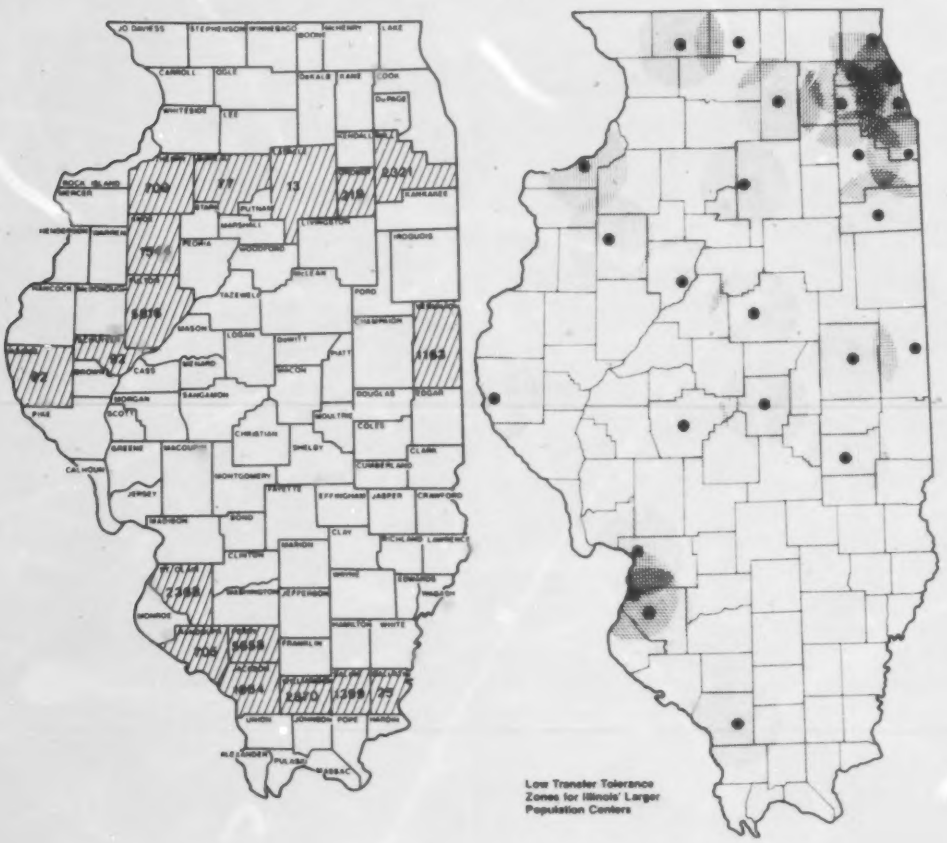


Figure 49. Acres of forested mine land are indicated for each county (32). These acres serve as part of the potential supply for recreational demand. Figure 50. Recreational activities in low transfer tolerance zones include picnicking, horseback riding, swimming, hiking, and fishing.
(Courtesy of Illinois Department of Conservation)

Fulton, Grundy, Henry, Knox, Perry, St.Clair, Vermilion, and Will counties exhibit good potential for the development of these types of recreation. Most of the counties mentioned already have developed some of their recreational facilities on mined lands. Adams, Jackson, and Williamson counties, which lie in low transfer zones, can meet their recreational needs with other lands.

Medium transfer tolerance zones extend one hour of traveling time from major population centers of Illinois. Activities that would be compatible with surface-mined lands include fishing, hunting, hiking, canoeing, and possibly water skiing and sailing if waters are widened and dangerous obstructions are removed. All counties with forested surface-mined lands, except Gallatin, lie within medium transfer zones. Areas with highest potential for these types of recreational development appear to be

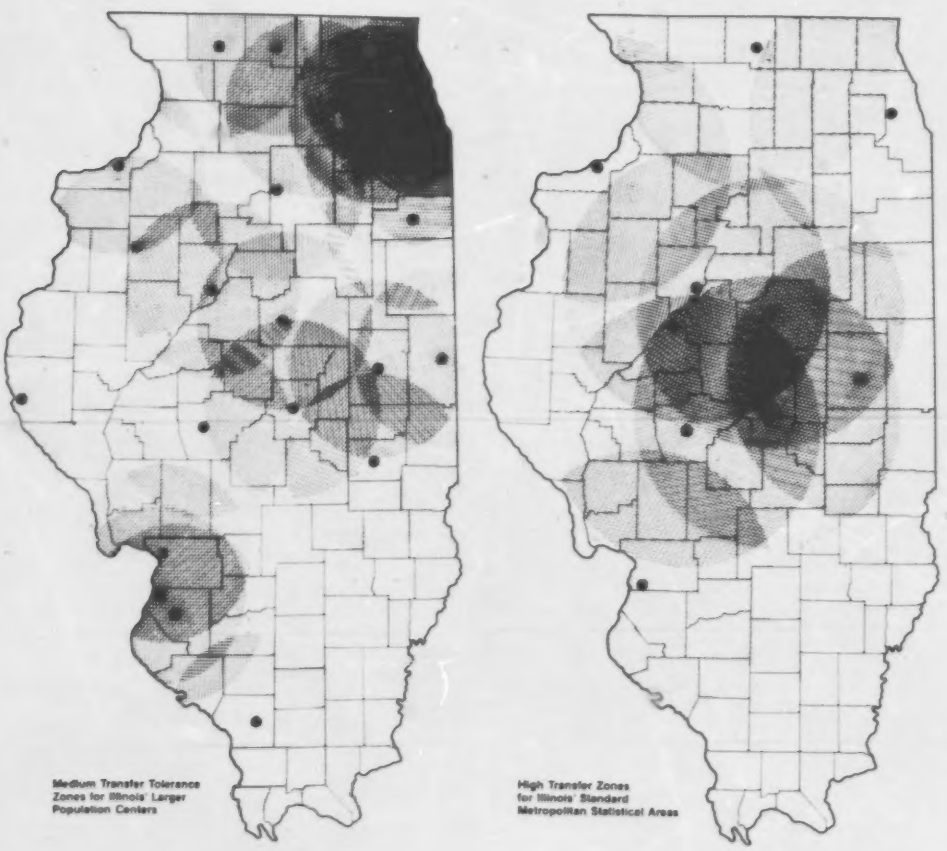

Medium Transfer Tolerance Zones for Illinois' Larger Population Centers
High Transfer Zones for Illinois' Standard Metropolitan Statistical Areas

Figure 51. Recreational activities in medium transfer tolerance zones include hunting, hiking, canoeing, water skiing, sailing, and fishing. (Courtesy of Illinois Department of Conservation) Figure 52. Recreation in high transfer tolerance zones includes hunting and camping. (Courtesy of Illinois Department of Conservation)

Fulton, Grundy, Henry, Knox, Perry, Randolph, St.Clair, Vermilion, and Will counties.

High transfer tolerance zones extend to two hours of traveling time from major population centers of illinois. The two activities that would be most compatible with surface-mined lands are hunting and camping. All counties with forested surface mines, except Adams, Gallatin, Jackson, Saline, and Williamson, lie within high transfer zones.

Re-created Lands for Recreation

The success of recreational clubs in Fulton, Grundy, Knox, and Will counties and of state parks in Perry and Vermilion counties supports the idea that previously mined lands may appropriately be used for leisure activities.

Pyramid State Park is an excellent example of the usefulness of forested mined land for recreational activity. This park offers the user a bounty of traditional outdoor activities along with the opportunity of enjoying these activities in a secluded atmosphere. Other notable features of the park are a horse camp and trail and the tremendous growth of morel mushro[illegible] which occur on the forested spoils during the spring. Scores of people may [illegible] seen exploring the park in search of these mushroom delicacies during the three or four week period in which they appear.

Although limited development, including roads, trails, camping, and picnicking areas, has taken place, the user still experiences a sense of seclusion due to the heavy growth of trees on the mine spoils. Further developments at the park should take place only if this sense of seclusion can be maintained. The opportunity to find seclusion is the prime drawing card for many people.

Figure 53. Safe swimming areas may necessitate development of shallowly sloping beaches on shores of surface-mine lakes. In the densely populated area of Will and Grundy counties swimming areas receive intensive use.

Surface-mined lands may also be used for newer types of outdoor activities which are growing in popularity. The rolling terrain provides the variety and challenge sought by operators of trail bikes and off-road vehicles. Mine spoils do not contain delicate natural features which are often of concern to environmental groups. Tree plantings provide natural boundaries to absorb spillover of noise and screen trail bike areas from zones with other activity.

Previously mined lands may require but very few changes and minimal outlay of money to be made into areas suitable for a diverse range of outdoor activities. A distinct advantage in using these lands for recreation is that it can take pressures off unmined land in areas where every acre is coveted.

Conclusion

Many considerations are involved in determining whether a forested mined area should be developed into a recreational center. Paramount is the ownership of the area. Often, mining companies which retain ownership of mined lands have a positive attitude toward recreational development. The mining industry, however, may have apprehensions about becoming involved with recreation.

These apprehensions include bad publicity and liability for accidents, damage to nearby equipment, and conflicts related to zoning because of revenue loss to a community. The mining industry has been asked to give away lands and, after agreeing in some instances, has been plagued by recreational interests impatient during the long-term duration of mining (77).

One possible solution to ownership difficulties would be to have the public agency which is responsible for recreational planning arrange a lease agreement of nominal value with mining companies. That agency, in Illinois the Department of Conservation (DOC), could assume responsibility for management of the land. Such an agreement has precedent in recent DOC management of utility company land. The obvious benefits from such an arrangement would be that the state would acquire more land for recreation at low cost and the mining company would be relieved of management responsibility for recreation.

Other considerations may be the cost of land development for recreation and the availability of funds. As mentioned before, quality recreation on surface-mined lands does not always necessitate a large outlay of money for extensive development. If the site does require drastic modification it may not be feasible to invest the money in development.

At the federal level the U. S. Department of the Interior (USDI) coordinates programs for reclamation of surface-mined lands. In 1973 the USDI Bureau of Outdoor Recreation sponsored regional conferences in each of its seven districts on the topic of reclamation of surface-mined lands for outdoor recreation (77). The Bureau supports financial assistance programs, particularly if recreation is the result of the reclamation. There is no federal funding authority especially designated for reclamation for recreation, but the Bureau's Land and Water Conservation Fund is one source for assistance. In Illinois a state liaison officer has been established in Springfield (78).

The overriding consideration in determining recreational development on surface-mined lands is reclamation legislation. Under current state and federal reclamation regulations many features which make mined lands desirable for recreational development are discouraged. Since September 1971, no surface-mining permits have

Figure 54. Access roads and boat loading ramps are primary components of recreational development on mined lands. Expensive development was not needed to develop this popular fishing spot at Pyramid State Park.

been issued in Illinois for recreational use (40). Near areas where recreational demand is high, such as the St.Louis metropolitan region, it may be beneficial for surface-mined lands to be affected by the law differently than they now are, to allow for recreational development. The conversion of lands mined under the present regulations to recreation areas seems unlikely.

Education and Interpretation

More than 23,000 acres of Illinois surface mines have been replanted to trees; over 51,000 acres have been naturally stocked with trees. Though this is less than one percent of the land area in Illinois, the educational opportunities which it represents are extensive.

Educational ideas are applicable in some manner to people of all ages. The depth of any environmental study may range from awareness and appreciation to a detailed and sophisticated analysis. The following suggestions may be adapted to a variety of educational experiences — scouting groups, Audubon outings, park interpretation, formal classroom instruction, or university research projects.

One overriding theme is that forested surface-mined land is best studied by direct experience. Issues of strip mining, whether environmental, social, economic, or legal, become alive through first-hand experience.

After reading this section educators should be able to answer the following questions: 1) How have educators utilized surface-mined sites in the past? 2) What constraints may there be to having access to a surface-mined site? 3) What are some of the opportunities that could be used with my learning groups for studying the unique environments? 4) How do I gain access to resources for such studies?

Present Utilization

A number of educational uses already exist on surface-mined land. The most intense educational use has been initiated by universities which have used and continue to use forested mines for research purposes. A prime example is Pyramid State Park, once the Pyatt Research Area of the Southern Illinois University Cooperative Wildlife Research Laboratory. Numerous investigations have provided data from this tract of land. Topics of research have centered on wildlife analyses and recreational uses.

The USDA Forest Service Palzo Project has involved several departments at Southern Illinois University. The thrust of their investigation is the revegetation of acid spoils in Williamson County. These spoils have been treated with municipal sewage sludge. Tree species are being investigated for their ability to act as a biotic storage reservoir for potentially toxic heavy metals within the sludge.

Quasi-public groups have engaged in informal learning activities to a minor extent. Scouting groups have planted trees on mined areas used for recreation in Grundy County. From this activity the scouts have learned about methods of obtaining, planting, and caring for trees.

Three state parks have incorporated surface-mine spoils within their boundaries. Six acres at Goose Lake Prairie State Park are currently an experimental revegetation project funded by the Illinois Institute for Environmental Quality. Pyramid and Kickapoo State Parks constitute 4209 acres of public land mostly in tree cover. Informal public education has occurred through visitor usage. A full-time interpreter at Kickapoo State Park has demonstrated facets of the landscape to interested visitors, occasionally filling the Department of Conservation voyageur canoe to capacity and illustrating at close range the aquatic and terrestrial changes in plant and animal life following mining.

An Aside on Future Educational Use

The possibility of further educational use of forested surface-mined land depends on the cooperation and commitment of many public and private groups. With the diminishing acreage of open space the educational value of forested surface-mined land will likely increase. Public school districts adjacent to mined land may seek access to these lands as outdoor laboratories. Owners of mined land, including mining companies, the state, recreation clubs, utility companies, or individuals, may be induced to make areas accessible to schools if provided with incentives. What incentive can a school district or other educational organization offer? A school may contract to care for the land and publicize its use in exchange for utilizing the area as an outdoor laboratory. Caring for the land may involve removing trash, checking erosion, improving habitat for wildlife and recreation, or more sophisticated services such as monitoring water flow and content of mineral and organic matter.

Greater support is needed to promote conservation and reclamation work in the grade and high schools. In Illinois, where managed land has become more prevalent than natural areas, the public needs to be shown the desirability and benefits gained by planting trees on lands disturbed by man. Universities will no doubt continue research on forested mined land because of the practical value of the research data and conclusions to the sponsoring agency and the public.

Suggested Educational Activities

The activities a group can pursue on forested surface mines are many and varied. The following are a few suggestions of activities, places to visit, people to contact, and materials for background information. Potential for use ranges from primary school level to adult education, depending on the type of activity and the depth to which it is pursued.

1. Surface mines replanted to trees represent a unique environmental condition of our contemporary landscape. Neither man nor nature can shape the land singly; a mine replanted to trees is synergism at its best. A listing of factors that are natural versus factors that are man-induced helps the observer to differentiate these forces and discover that many are not separable.

Another categorization of mined land is to list the state and federal reclamation laws and to determine ways in which reclamation of the land has been affected. By careful observation of the topography one can often determine the law that was in effect during reclamation.

2. Vegetation and landscape features reveal copious information. Historically, trees were planted by hand to stabilize the spoils. Some species were planted because of their fast-growing nature or ability to provide wildlife habitat. With the help of many volunteer trees, a canopy of branches may close over in the years following planting. Often smaller invading species create a dense understory favorable for wildlife.

Classes may wish to investigate which trees were planted by man and which trees were planted by nature. How did volunteer tree seeds arrive on the site? If such animals as songbirds, rodents, and deer are present, on which trees do they depend for food?

3. A class may wish to demonstrate how reclamation to a forest may be compatible with other uses and be economically feasible. With foresight, an outdoor laboratory on mined property could be managed for recreation, wildlife, and timber production. This type of outdoor laboratory would involve learning through planning, decision making, and action, rather than passive observation. The USDA Forest Service presents multi-use principles in its land management programs. Many of its publications are free.

4. In investigating a comparison of mined and unmined sites, other facets can be explored — the rates and types of change in plant and animal populations, forest canopy and understory development, soil characteristics, erosion rates, and water quality. If drainage water from the land involved is being monitored for water quality, institutions with suitable facilities may wish to investigate the possibility of their monitoring the site, sharing the results with involved companies or agencies, and using recorded results for their own research.

5. Mined land could provide the sites and stimuli for making an energy assessment. Such an investigation can involve calculating the energy inputs in mining and

Figure 55. An ecology class from Southern Illinois University studies the developing landscape at Pyramid State Park. Outdoor laboratories on forested surface mines provide first hand experiences for comparing managed and natural sites.

reclamation versus energy extracted in the form of coal. Another assessment might involve comparisons of energy inputs in different types of site preparation and the biotic energy to be harvested from each. The site may lend itself to a comparison of energy flows within forests which develop on mined property versus those of unmined lands.

6. During mining, rock layers such as shale, limestone, and sandstone, along with occasional coal left from mining, have been turned up to the surface. The mineral-rich rock fragments weather rapidly and release plant nutrients. These nutrients usually lead to increased plant growth.

The rocks at some surface mines, however, may contain pyrite, a trouble maker. Pyrite may oxidize and can produce sulfuric acid with surface waters, which in turn may dissolve rocks and cause an excess of minerals to be available to plants. Then vegetation may suffer toxic effects.

These areas illustrate the contrast with the vast majority of surface mines replanted to trees which are not toxic. They also demonstrate the importance of handling the overburden. Is the surface soil acid or alkaline? Litmus paper in a soil-water solution can provide a quick check. Is the soil composition and texture different from unmined forest sites in the area nearby?

7. Some sites in Illinois contain unique coal balls or other exposed rock material which harbor evidence of past plants and animals (46). Many ungraded surface-mined lands in Illinois are excellent areas for geologic or fossil studies (65). Types

of reclamation other than trees require some grading and would cover most fossils. End cuts which have been preserved expose the geological layering of the earth. The Illinois State Geological Survey provides free information to the public about strip-mined lands.

8. If mining is done under a stream or river the mining company must divert the water flow to another route. The changes in development of the stream channel can be documented. By using topographic maps, mining company maps, and by walking the present channel, a sequence of stream changes can be determined.

Lake, pond, and stream banks may also be studied for erosion and stability. To what degree has erosion been checked by tree roots and litter cover? How successfully has reclamation restored a stable land surface with high environmental quality?

9. Human values toward mined land versus unmined land can be studied. If one mentions strip-mine spoil, many people envisage an ugly and barren wasteland, row after row of rocky red or black banks with acid water polluting adjacent streams. In Illinois, toxic mines represented only seven percent of all spoils in 1971 (32). The fact that over 90% of spoils are successfully vegetated and not problem sites is seldom recognized.

Does your area contain surface-mined land? How do area people regard it? A survey of responses could provide a good beginning to understanding the social climate of an area.

10. The reclamation of mined areas is a land-use question. The issue is current, controversial, and complex. How land should be utilized and reclaimed to further the best interest of the public and the owner is a meaty topic to pursue (18, 19). Interested factions may clamor for reclaimed land to be developed for woodland, pasture, recreation, cropland, or myriad other uses. Each type of land modification after mining may be suited to a limited range of vegetation.

A school class could interview the interest groups which support certain kinds of reclamation and compare the proposed benefits of each. County governments, coal companies, and area Department of Conservation biologists and foresters are people who can be contacted. Students may wish to trace the decision-making process which will determine the ultimate land form and its use.

11. Many state and federal laws govern how land surface-mined for coal must be mined and reclaimed. Other chapters of this bulletin detail those laws. Classes may enjoy reading and comparing each law and its accompanying set of regulations.

In addition, coal mining companies must abide by many other regulations. A regional Illinois Environmental Protection Agency officer may be able to describe those laws which include the federal Clean Air Act, Water Quality Act, and Resource Conservation and Recovery Act.

Suggested Interpretive Activities

Interpretive efforts on forested surface-mined land could be developed to enhance and guide the visitor's activities. Protected displays could show photographs of the pre-mining, mining, and post-mining progression of the land development. Artist's representations of the coal formation period would help the visitor realize how fleeting is a given state of the land. Artifacts or models of mining and reclamation equipment could be displayed, accompanied by demonstrations of the processes involved. An audio or visual display might include the story of one day's work by one of the men who moved the earth.

Sites which were mined for coal and now support tree growth offer great opportunities for interpretive studies. Both professionals and budding interpreters in a college curriculum often overlook that which is not called "natural". Pyramid State Park, which has no interpretive personnel or facilities, offers the college interpretive class a training site for development of self-guiding or low maintenance displays. Trail signs could illustrate ecological, historical, and economic principles that are displayed by the land.

What are some of the sights to see and phenomena to observe while walking on a wooded mine site? The following section is an example of what an interpretive walk might include.

Reading the reclaimed landscape

The scene could be in northern, eastern, western, or southern Illinois, Kickapoo State Park, a farmer's timber close to Victoria, a secluded residential lot in Goose Lake Corporation, or a wooded tract awaiting re-mining by Southwestern Illinois Coal Corporation in Randolph County. How are these four places related? The common factors are strip mining and trees. A casual observer of any of the four pre-law landscapes sees man-sculptured rows of low hills carpeted with trees and shrubs.

Suppose the observer is walking the Randolph County site piecing together clues, reading the landscape to understand the land better. Laying aside the dense vegetation, he notices loose, rough-textured earth. These soils seem an anomaly

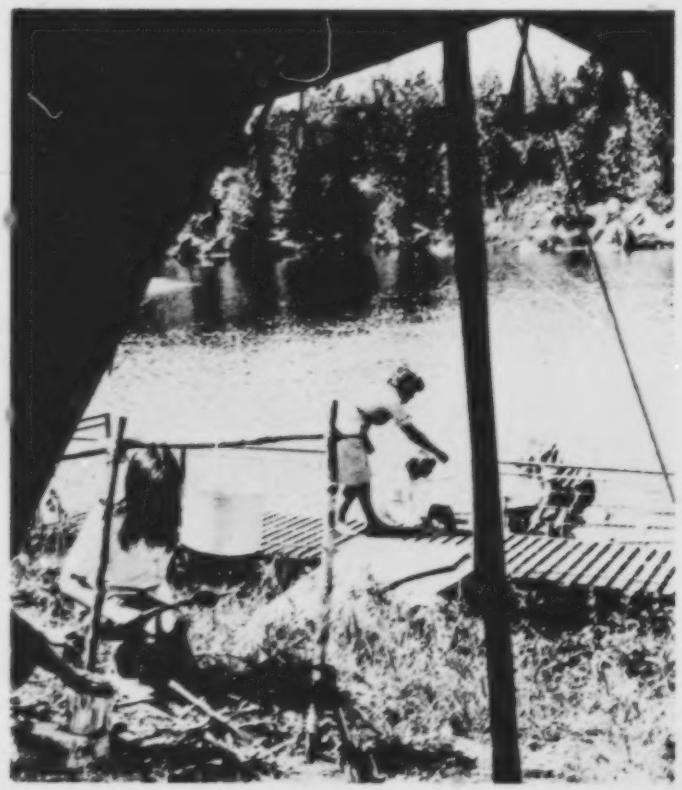


Figure 56. From the vantage point of their tent we can see Girl Scouts practicing skills of outdoor living. The surface-mine lake is bordered with pine, sweet gum, walnut, and tulip trees. (Courtesy of Peabody Coal Co.)

amidst the residual clay soils that cover the unmined land. Surrounding farmers may have problems with their soils being too acid to grow bountiful crops. Here the upturned limestone, a mineral treasured for its basic properties, occurs in abundance and provides the optimum site for yellow sweet clovers. Not surprisingly, bees skirt around the visitor on errands toward the nectar-bearing flowers. The sweet-scented black locust trees attract the bees, but also attract black locust borers. Rows of infested trees among the thick sprouts remind us of the past destructive activities of the borer.

Other types of trees also appear in organized rows, obviously planted by man. The row of pine trees with their restricted growth reveals disharmony with the site conditions. The observer's premise that the area is alkaline is reinforced; pines prefer a more acid condition.

The visitor's eye turns to the gross topography and he wonders how the land was mined. If the land is a series of long parallel ridges a power shovel was probably used to mine the land. Draglines often leave the affected site in conical piles or sharply serrated ridges. A rotary wheel deposits spoils in irregular arcs with short, steep slopes. Land mined and reclaimed according to the 1971 Surface Mine Conservation and Reclamation Act may have been graded and therefore not reveal the mining method to the observer.

The visitor may be aware that the present forest is soon to be cleared and that the mammoth stripping machines will re-enter the area to expose yet another seam of coal. The presence of two or more coal seams implies that the geologic past has been a yoyo in eon-long slow motion — seas pushing over the land, then receding, making way for shallow swamps, then again pushing and receding.

What would the landscape look like after the overburden had been removed by man for the second time? Would different materials compose the overburden and create different conditions for the plants to grow? Would grading be done this time? Would lakes be left behind? Man would decide the gross topography; nature would decide the success of the plants and animals on the site.

Where should we go to read reclaimed landscapes? Any mine area could serve. The best arrangement, however, is to work with the state agencies, educational institutions, development groups, and coal companies which offer access and help for visitors. We list several of the important places to seek that help.

Places to Go and Things to Do-
A Resource List for Educational Leaders

Addresses or phone numbers for a department, agency, or company not listed here will be found in the Reclamation Directory which is Chapter IX of this bulletin.

1. Two state parks on forested surface mines offer places for viewing pre-law lands and the process of revegetation. For more information, write the parks and ask for their descriptive pamphlets.
   a. Pyramid State Park, RFD 1, Box 115-A, Pinckneyville, Ill. 62274
   b. Kickapoo State Park, RFD 1, Oakwood, Ill. 61858
2. The Department of Conservation (DOC) features an article on surface-mined land in *Illinois Outdoor Recreation*. They also have a small brochure on the proposed wildlife area, *Banner: A Marshland Legacy*. Both are available from the DOC, Information and Education Division.

3. The Illinois Institute for Environmental Quality (IIEQ) distributes information to the public, free of charge. Write to their Environmental Information Center and ask for their literature about reclamation. IIEQ also distributes a quarterly review of publications.

4. The Illinois Environmental Protection Agency has addresses of offices to contact for environmental information.

5. The Illinois State Geological Survey offers a wide variety of resources, technical and nontechnical. One can request their *Selected List of Available Publications on Coal*. The Survey also provides *Geological Science Field Trip Guide Leaflets*. The list of leaflets can be requested and nearby areas which have mine locations can be selected. Each leaflet covers a one-day tour and gives detailed explanations of the geology of the region.

6. The Illinois Department of Mines and Minerals issues an annual report on the status of reclamation in the state. The reports are available from the Supervisor, Land Reclamation Division.

7. The Palzo Restoration Project to reclaim toxic spoils is coordinated by the USDA Forest Service, Shawnee National Forest, Harrisburg, Ill. 62946.

8. The USDA Forest Service, Eastern Region, 633 W. Wisconsin Ave., Milwaukee, Wis. 52303, has several teaching packets that are helpful in a study of our forests. Write for: "Teacher's Forest Fire Prevention and Conservation Kit".

9. Write to the appropriate office for Illinois: USDA Forest Service, North Central Forest Experiment Station, Folwell Ave., St.Paul, Minn. 55108, for publications about its multi-use program for forests.

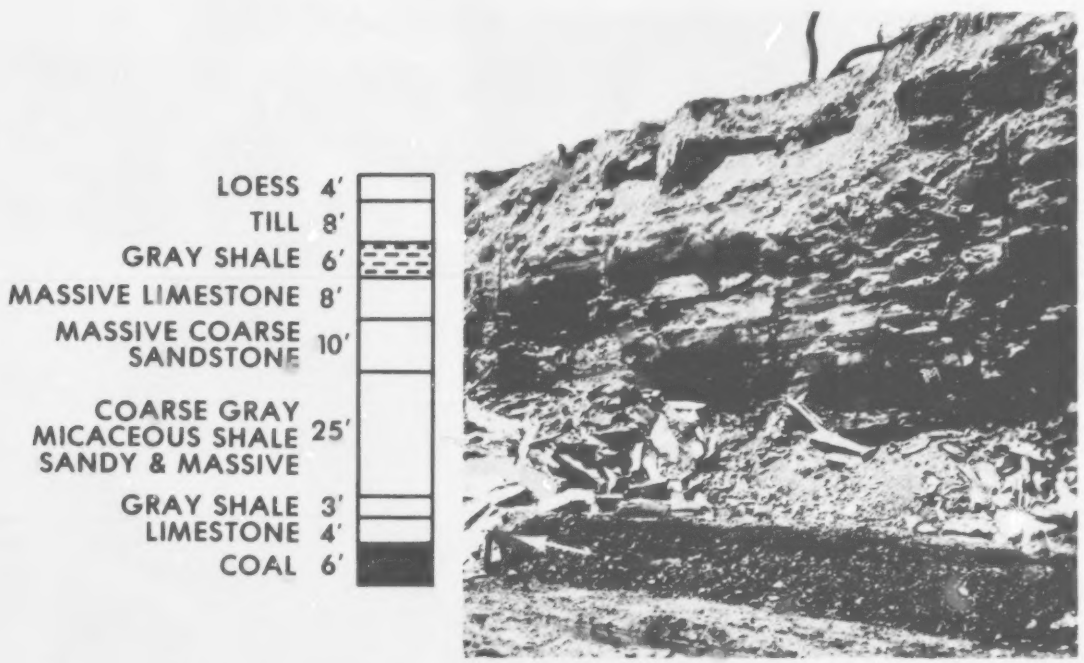


Figure 57. A high wall in Saline County contains all the material needed for a geology lesson in sedimentation. A man in the lower left corner of the picture lends scale to the depth of each layer. (Courtesy of USDA Forest Service)

10. The Field Museum of Natural History, Chicago, has publications and exhibits of fossils from coal fields. The Curator of Fossil Invertebrates can issue permits for fossil hunting at Pit 11 near Braidwood.

11. Several coal companies offer public information and tours. The Bill Mullins Recreation Area near Percy, maintained by Southwestern Illinois Coal Corporation, is an excellent example of multiple land use and cooperation with the surrounding communities. Tours of the company lands are available; contact Manager of Land Resources. Peabody Coal Company and Amax Coal Company distribute information about the companies and tours.

Figure 58. Tully monsters, jellyfish, shrimp, and fish swam in the shallow waters covering Grundy and Will counties 300,000,000 years ago. Fossils of animals enable an artist to recreate the ancient seascape. (Courtesy of Field Museum of Natural History, Chicago)

12. The National Coal Association research arm is Bituminous Coal Research, Inc., 350 Hockberg Rd., Monroeville, Pa. 15146. A helpful free publication is their *Glossary of Surface Mining and Reclamation Technology*. It provides a basis for understanding technical terms.

13. The DuQuoin State Fair Grounds is open to the public year round. Most of the area is located on restored surface mines.

14. Recreation clubs on mined land in Fulton, Grundy, Knox, St.Clair, Vermilion, and Will counties can be located to request a tour. All are private and priority is given to members.

15. Goose Lake Corporation is a residential area east of Morris. A walk or drive through the area will show how housing can be adapted to spoils.

Figure 59. Surface-mine lands and facilities with related information offer many educational opportunities or "Places to go and things to do".

VI . Social and Economic Effects

Social Impacts

There are social impacts in reclamation to trees and to other alternative uses. Because society is strongly affected by the presence and absence of resources, the public has a great concern for their availability. Each of the alternative uses for reclaimed land is a resource opportunity. Policy for land reclamation can well be formulated from this basis of utilizing resource opportunities.

Strip-mine reclamation harbors an ambiguity yet to be well articulated. Who really pays for reclamation and, therefore, who should benefit from it? Though the land is reclaimed by the coal companies and generally retained by them, the reclamation costs are borne by the public as part of the price of coal. Who should have a claim on the final productivity? One solution is to ensure that management of the land is consistent with enlightened public policy and public interest, while allowing private interests to control the financial values. Current reclamation legal requirements reflect this approach.

Public tax revenues may be affected by the use to which the land is reclaimed. Although they are not uniform from county to county, present tax structures often discourage the adoption of certain reclamation alternatives, particularly forest. The principle which pervades Illinois assessment is that land should be assessed on the basis of its highest and best use.

If land previously yielding a yearly income is reclaimed to forest but is not re-assessed, the owner is disadvantaged until the trees mature. On the other hand, the tax base for local governing bodies is diminished if the land is re-assessed to reflect the difference in income yield.

Much land in forest is being mined and returned to row-crop standards following recommendations of county boards. Distant consumers pay the greatly increased costs of spoil handling. The coal company then pays increased taxes if the land is re-assessed. These added fiscal burdens may not result in a long-term economic benefit to society.

Impacts of taxation policies will be discussed in greater detail in the following section on economics. This present section focuses on the social impacts of possible post-mining land uses and on regional conditions affecting reclamation alternatives. Major differences in social impacts of reclamation are noted for the Chicago region, western Illinois, southern Illinois, and southwestern Illinois near St.Louis.

Alternative Post-Mining Land Uses

Timber use

Because long-range needs and rewards tend to be under-represented in market economics, forestry worldwide is being looked at from a broader perspective.

The U. S. Department of Agriculture predicts that our tree harvest will exceed growth by the year 2000 (76). While there are many materials that can substitute for wood products, they usually require more energy for processing, are non-renewable and non-biodegradable, and lack the insulating and aesthetic values of wood. Ultimately all members of society would suffer from an inadequate wood fiber supply.

Not all forests are potential sources of commercial wood fiber. Private owners hold 61% of the forested land in the U. S. (73). Many are farmers who have wood lots on their land, and it is very hard to make such lots integral to either modern commercial farming or to a forestry operation. Another kind of owner is becoming common — those who procure land for some aesthetic or psychic satisfactions that have nothing to do with economic return and which, in fact, may be incompatible with financial considerations. These kinds of ownership are a good indication that forests fulfill many different needs. This diversion of forest ownership, however, means that other sources of forested land must be found for timber supply.

Suppose forest is planted on reclaimed land — what impact can neighboring communities expect? The forest creates a labor demand for maintenance, timber cutting, and timber processing. Harvesting the timber crops takes the largest amount of labor in forestry, though it is becoming increasingly mechanized. Woods-crew labor tends to be hard, dangerous, semi-skilled, seasonal, low status, and poorly paid. This kind of work occupies only a relatively few people. In 1971, 50-100 persons, skilled and unskilled, would be needed to cut and haul wood for a minimum-size pulp mill (200-ton daily production) (13).

Timber processing jobs are comparable to most factory labor: fairly well paid and steady. The mill cited above could be expected to pay $5000 per day for wages, salaries, and electricity. Total economic reverberations are large. Based on research conducted in the South, the Arkansas Forestry Commission reports that for every dollar paid for stumpage, $20 are added to the economy in processing, transporting, and packaging to produce a final product (3). This suggests that unless processing takes place locally, most of the real wealth generated by timber is carried outside the area.

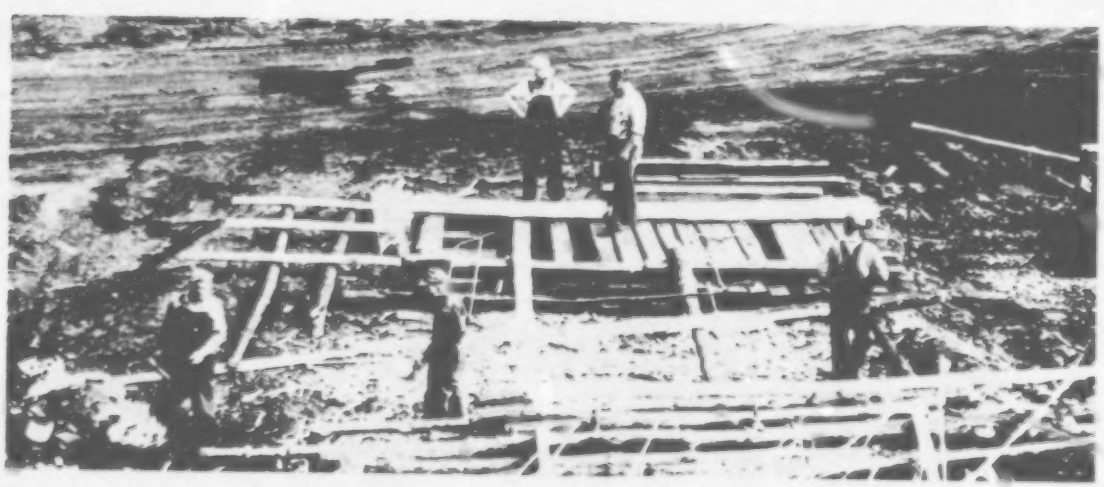


Figure 60. Labor for timber harvesting and processing stimulates a local economy. Forest management on surface-mine lands produces marketable timber. (Courtesy of USDA Forest Service)

The extent to which forest on reclaimed land might affect an area economically is difficult to determine. While it is possible to estimate timber yields, it is not possible to predict whether the yield, combined with future circumstances, will attract processing industries.

Apart from the employment aspects, the economic effect forest might have locally can be compared to the effect of National Forest land. Although National Forest land has been castigated as detrimental to the financial well-being of counties, a study by Beazley and Spencer (9) indicates it has not had a negative effect on the value of capital holdings. Indeed, it seems beneficial, since, located on the land poorest for farming, it encourages efficient use of other resources.

Even though reclaimed land is not usually poor, a forest's productivity is not realized immediately. Forest assets, both tangible and intangible, become increasingly valuable with age. Thus forest can be a means for including a time dimension in land use planning.

Recreation use

Designation of land to forest can be beneficial by accommodating social needs such as those reflected in the demands for recreation and wildlife habitat. Much pre-law land has been reclaimed to these purposes. These uses have many non-economic benefits, suggested by phrases such as "going fishing", "change of scenery", and "enjoyment of the out-of-doors", which are very real but difficult to assess. Only the impacts of this type of reclamation on the local economy will be discussed.

Because people generally spend little money while enjoying a forest environment, recreation tends to provide few employment opportunities, and they are usually seasonal. In most cases a local economy is not strongly affected by recreational use of strip-mined land. The direct economic effects on a local community of other alternatives such as wildlife management are also minimal.

In areas experiencing urbanization pressure, however, the impacts are greater. Not only do more people enrich their lives by using the forest in the ways mentioned above, but there may be a significant development of vacation homes. The impacts of this use are a seasonal version of those which accompany residential developments.

Residential and industrial use

Both residential and industrial uses of strip-mined land are compatible with a forested site. Forest and lakes make residential areas especially attractive. On industrial sites white pine and other trees can serve as a screen for both noise and view. Strip-mine lakes on forested sites are valuable as water sources.

As our population increases the need for both residential and industrial sites is obvious. The location of such developments on reclaimed land has some broad-scale implications, both negative and positive. It would perpetuate a pattern of scattering urban pockets across the countryside, and would add to energy waste problems through an increased need to commute and through the inefficiency which isolation fosters. If such pockets of urbanization are going to occur, however, it seems that new, empty, reclaimed land is a better location for such developments than previously undisturbed rural areas. Agricultural land and communities would be preserved, urbanization pressures would be satisfied, and the new economic sectors could replace mining.

The success of residential developments on stripped land near Chicago has demonstrated their value. Initially the existing communities were skeptical about the desirability of the development, but resistance has faded and some local people have bought new homes on the reclaimed land. While various kinds of housing, such as apartments, could conceivably locate on reclaimed land, the attractions of seclusion, water, woods, and diverse terrain make it likely that single residences will preempt these sites.

The changes which reclamation to forest can bring are pertinent to a consideration of industry's impact in two ways. Not only can the land be a site for industry but the increased wood fiber production itself may attract a wood-processing industry. The industries which are currently opting for rural locations, those perhaps most likely to be attracted to reclaimed sites, tend to be labor intensive. They pay low wages and hire mostly unskilled workers, many of whom are women or young people. Because these workers often were not previously in the labor force, neither the number of unemployed nor the number of employed who entirely support a family changes substantially (69). If the operation is seasonal, this is all the more true.

Transformation from a rural focus to an urban one brings social changes. Both residential and industrial developments can bring new people into a traditional community. This brings financial and lifestyle changes. Municipal revenue can be affected through adjustments of service demands and tax bases. Service and taxation boundaries which do not coincide can create severe problems. The influx of newcomers can change political balances and other traditional ways of doing things. Social mobility increases and class structures become more definite. Families and towns become less self-sufficient and more interdependent.

The mining which preceded reclamation, however, had already changed the social organization. Additional changes that residential and/or industrial development might bring would be less disruptive here than elsewhere.

Figure 61. Residential land use is compatible with an unleveled forest site. Lakes provide added attractions: places to swim, boat, fish, and enjoy a scenic vista.

Use for food production

The foregoing uses of reclaimed land are compatible with growing trees. Uses for food production are not. This land use conflict has not always existed. Historically most farmers had a woodlot from which they derived materials and other benefits. The "woods work" was best done in winter, when the farm required little attention, so it supplied an off-season livelihood. This changed as farming and lumbering each took on the aspect of large scale, efficient, single-product operations. The current emphasis on food production overshadows the fact that the traditional farm produced both food and fiber. This emphasis on food production has been a focus of great social concern.

One viewpoint is that as worldwide population increases all possible avenues to meet expanded food needs should be explored. In reply, a wide body of information has been gathered which demonstrates the problems with dependency upon external sources of food. The least subtle expression of it is that feeding people creates more people. A human population so large that every possible resource must be exploited for food is undesirable for both social and survival purposes. Damaging effects are the losses of independence, of self-sufficiency, and of community cohesion. These result when societies do not have the ability to provide adequate food for themselves. Total emphasis on food production would only postpone large problems to a later and more disastrous day.

This is not to suggest that good agricultural land should not be fully utilized, but rather that the greatest social benefit grows from a good fit between a resource and the use made of that resource.

Inappropriate use almost inevitably has undesirable social consequences, and they are felt most strongly locally. Examples of this can be found in Illinois. Some areas simply are not desirable agricultural land. The result of row cropping them is the marginal or subsistence farm. The farmers themselves are in double jeopardy from low prices in a bumper-crop year and an inadequate crop in a poor year. Clearly, reclamation to row-crop purposes in those areas with an historical dependence on marginal farming merely aggravates existing problems.

A different reason put forth for using row crops on stripped land is that traditional family farms and the way of life they represent should be preserved. Some of the elements of this life are the extended family, participation in church and other organizations, and a spirit of independence. Small farms also support a larger volume of retail business in neighboring towns than do large farms (56). There are good reasons to maintain small family farms. Nationwide, however, the acreage per farm is getting larger, while the number of farms and the total farm acreage are declining. Where small farms do prevail, off-farm income is becoming more and more important.

Illinois is no exception, and reclaimed land seems extremely susceptible to these trends. This is not surprising since it is long association with one piece of land and one community which is the real basis of traditional family farms. Land which has been reclaimed to row crops has generally been leased to established farmers who want to enlarge their operations. New, small, family farms simply do not appear to be a viable option for strip-mined land. It seems almost inevitable that land reclaimed to agricultural purposes will be managed on a large scale; this land use only makes sense if the land is genuinely good productive land.

Orchard production is not subject to many of the issues that surround row cropping. Its social impacts on local areas stem from its seasonal, low-paying, and

labor-intensive employment aspects. On a sufficiently large scale, an orchard operation may attract migrant labor, which temporarily strains local resources. On a smaller scale, it absorbs local summer labor. Horticulture requires experienced operators, so it cannot readily be taken on by most local farmers. Sometimes processing facilities grow up around orchards. These have seasonal and low wage characteristics which parallel those of the horticulture operation itself.

Pasture for grazing, another food-producing alternative for strip-mined land, engenders few local social changes. It provides very little employment. Local stock processing can provide some jobs, in which case the effects are similar to those of industry. As in the case of timber, when stock is shipped out of a vicinity for processing, most of the potential wealth represented by the livestock is realized elsewhere. Though pasture is a good use for reclaimed areas, feedlots have started to replace all but the cow-calf aspect. Environmental legislation may speed this process. Profitable pasture operations in Illinois could become obsolete.

Region-Specific Impacts

The local impacts of land use can really only be judged within an actual socioeconomic context. Following is a brief indication of how several reclamation alternatives might fit into four major areas of Illinois which have strip-mined land.

Chicago region

The stripped land near Chicago is virtually all in use. The success that residential and recreational developments have enjoyed there is ample evidence that the forest vegetation, lakes, and varied terrain are socially desirable for such areas. The changes and problems such developments may generate for the surrounding communities would only be relocated if some other area absorbed these pressures, and in rural areas these problems would be compounded by a loss of farm land. Continued planting of trees on these areas would make them still more desirable for their present uses and concurrently develop the productivity of the land. Land

Figure 62. At one time pasture dominated land-use alternatives for reclaimed land.

Figure 63. Is it better to preserve open space or to press for immediate development?

needs for future industrial expansion can also be well met within strip-mined areas reclaimed to trees.

Western Illinois

This area offers another situation. It has good agricultural land and is dominated by farming. There are few other land use pressures. Though a planning commission (16) commented that, "...most residents of western Illinois would not consider unleveled, tree-covered spoils as reclaimed", such land adds welcome variety to the landscape. The commission favorably cited recreational and residential uses of pre-law land. There are currently, however, few demands for such land uses, so the benefits that trees or other alternatives might offer are generally not well recognized here. The area is currently experiencing a slight population loss (64). Future urbanizing pressures could change this situation and the land use needs of the region.

Southern Illinois

Southern Illinois has been characterized as a depressed area for at least the last half century. The condition is largely a result of overdependence on primary production: mining and agriculture. Some changes are occurring which signal better times, but no economic or social boom is expected. Recommendations for the area are a diversification of the economy, development of steady income sources, and an upgrading of the labor force through an infusion of skills and training (30).

The relationship between these recommendations and land reclaimed to forest is ambiguous. As an economic resource, timber is yet another primary product, but it does offer diversity. The employment it provides fits well into the local labor supply, but would probably not introduce new skills into the area. Recreational and other multiple uses of forest are not likely to bring a new or vital economic dimension to southern Illinois mining regions.

Forest in conjunction with homesites or industry appears to have more to offer. Quality housing is in short supply around many centers of population. Manufacturing is already the largest employer in much of the region (29), and light industry seems well suited to the area.

Low-wage, labor-intensive industries, however, have a paradoxical impact. While there is a neat fit between the labor supply and labor demand, this unfortunately emphasizes rather than changes the characteristics of the local labor force. The employment fluctuations and location instability of these industries are also detractions.

The different food production alternatives of tillage crops, orchards, and pasture produce different impacts. Row cropping is an investment in primary production dependence, and the income it provides is seasonal rather than regular. Already, at least 55% of the farmers in the region have a source of income and employment other than their farm. Reclamation to row crop in this part of the state would emphasize the trend toward agribusiness and increasing farm size, without changing the dependence which has proved detrimental to the region.

Fruit orchards have been recommended for southern Illinois. Growing fruit is a good use of physical resources, and adds to a diversified economy. Unfortunately, its relation to the human resource has the same drawbacks that low-wage, labor-intensive industry does. The seasonal nature of the work emphasizes this pattern. Furthermore, despite the high unemployment rates of statistical reports, orchards currently operating in the area are experiencing difficulties obtaining the labor they need at a price they feel they can afford.

The third agricultural alternative, pasture and grazing, is suitable for the region's resources, but in the past southern Illinois has been hurt by dependence on sectors of the economy which declined in general importance, and pasture is likely to undergo the same fate.

No one reclamation alternative is ideally suited to southern Illinois. This suggests that using forests to induce efficient use of resources in the region now and for some time into the future could be helpful to the area. Although acting to effect changes is important, reserving options and planning for changes and developments which cannot currently be identified are also valuable. For example, England pioneered industrial development, but was eventually at a disadvantage because she was committed to the early technology. An ability to adapt is the trait which leads to survival in the evolution process. Southern Illinois, now coming out of its depressed state but not committed to a particular direction of development, is in a good position to wait until desirable land uses become obvious. Forest is a means to do this. In the meantime, it matures, becomes productive, and is a desirable land use in and of itself.

Southwestern Illinois

Southwestern Illinois offers a different planning challenge. In southern Illinois the challenge is to husband the land wisely until a specific need dictates a use for

it, while in southwestern Illinois, a growing area in close proximity to St.Louis, the need is to allocate land properly to the multiple demands. Agriculture is productive and, except for the western industrialized edge, has traditionally dominated the area. Now light industry is dispersing over the region. There is need for housing. Pockets of single residences are appearing throughout the region. A planning commission (71) commented that, "One of the most urgently needed programs in Madison and St.Clair counties is an open space program".

These characteristics delineate a conflict: Is it better to preserve open space for present recreation needs and unspecified future needs, or to respond to immediate pressure for new development? Forested reclaimed land is a resource which is suitable for either option. Undeveloped woods and lakes fulfill open space requirements. Furthermore, the area's under-utilized wood-fiber resource (72) would be improved, making harvest more likely. If homesites and industries locate on reclaimed land, present development needs are met while relieving some of the pressure on agricultural land. Row-crop, horticulture, and pasture reclamation alternatives are all viable, and in cases of exceptional productivity are desirable, but they do not alleviate current land-use pressures of the region.

Economic Return

Closely tied to social impacts are economic impacts beyond those discussed on jobs, land use, and community function. How do reclamation practices affect investment opportunities, long-term timber resources, and tax revenues? Is planting trees profitable in terms of an ultimate economic return? Earlier discussions in our bulletin emphasized the high productivity of pre-law lands for tree growth.

Economic analyses of profits from timber or pulpwood or other forest products involve several factors and assumptions. An investor in tree planting must be able to tolerate a level of uncertainty, as well as plan for an extended time period. These ideas were summarized for black walnut timber by one writer:

> A large publicly held corporation would view the question (of investing in timber) quite differently than an individual investor. ...Investing in high quality timber, walnut in particular, appears to provide an excellent opportunity to accumulate wealth. The investor who includes timber in his portfolio with this objective in mind will not be disappointed. Walnut is inappropriate for the investor who is seeking a quick return (34).

The data available for timber growth on reclaimed land are limited. Most timber stands on reclaimed land have not had consistent timber management or growth monitoring, nor have these stands reached full maturity.

The discussion which follows assumes that properly managed top quality tree species on suitable sites are profitable in surface-mine reclamation. We focus primarily on investment and tax considerations with emphasis on costs in the initial reclamation process.

Investment Opportunities

A big question mining companies and the larger society would want to ask before supporting tree planting on some strip-mined land is: "Will this reclamation

alternative be as beneficial as other alternatives including row crops and pasture?"

The answer is yes — but only if the site can be reclaimed in a manner that will be advantageous to tree growth. Research is in progress, testing how well trees can grow when planted on a site prepared under the current Illinois reclamation law.

In comparing the profits a mining company could expect from the different land-use alternatives, the returns must be reduced by the cost to reclaim the land. Costs to reclaim the land under present reclamation standards are subject to extreme variability. The variability is due to the chemical and physical make-up of the stripped soil, type of equipment used, labor source, fuel, supplies, repairs, insurance, etc. Reclamation costs differ between mining companies, and between different sites for the same company.

As presented in conjunction with reclamation legislation, a mining company must post a bond in order to receive a mining permit. The bond amount is intended to be sufficient to cover the costs to reclaim the land if the mining company does not perform this obligation. The specified bond amount does not necessarily reflect the cost which would be incurred by the mining company itself, but rather the cost to have the land reclaimed if the mining company did not do the reclamation. For the first six months of 1977 the average bonding value per acre required by the Department of Mines and Minerals has been $2952 (26). This figure, approximately $3000 per acre, represents a minimum amount for reclamation, with the actual costs for a mining company generally being above this level.

Reasons why the actual cost might exceed the bond amount are the variability factors mentioned before. A mining company might use union labor for its reclamation work, while the bond amount would estimate the labor expenses at a lower wage rate than mine union rates. Actual reclamation costs may be as high as $7500 (2) to $14,650 (24), as contrasted with the $3000 bond amount. Comparisons between

Figure 64. This black walnut measures up to needed fiber resources. With forest management surface-mine sites can produce top quality timber.

various reported actual costs are difficult, since these figures usually do not specify which costs have been included and which reclamation standards are being achieved by the reclamation. Whatever economic returns a mining company expects from an investment in a particular land use must therefore be reduced by a minimum of $3000 and, more realistically, by a figure somewhere between $7000 and $15,000 to reclaim the land according to present Illinois standards.

Reclaiming the land in a manner to achieve the best timber growth, instead of immediately restoring row-crop yields, could result in a cost savings to a mining company of at least several thousand dollars per acre. The worth of this savings after a particular number of years at a given rate of interest can be calculated by using a future value factor table (58). If one assumes that a savings of $2000 per acre was invested and accumulated interest at 8% for 50 years, a rotation length suggested by Callahan and Smith (14) for a walnut plantation, the value of the cost savings would be:

$$\$2000 \times 46.9016 = \$93,803.$$

This savings alone is larger than the returns most land reclaimed to row crops could generate after 50 years. The application of the future value factor shows that for land in row crops to be able to generate $93,803 after 50 years, the land would have to yield a net return of $163 per acre each of the 50 years ($93,803 / 573.7702 = $163.48).

Another aspect which an investor would want to consider in comparing alternatives is the amount of initial capital required for crop or pasture or forest because of machinery, vehicles, fencing, and buildings which are necessary. With timber, the initial investment may be minimal. For needs such as access to the timber area a mining company would likely already have equipment in its mining operations which could be used. Thus if a mining company is interested in an investment which will not require an initial capital investment and will not tie up large sums of capital, timber may be much more attractive than crops, assuming the lower reclamation costs.

Effects on Timber Supplies

Recent projections by the USDA Forest Service (76) indicate the nation has entered a critical period concerning growth and removals of timber, provided the projections are accurate. These projections reveal that removal of softwoods already exceeds growth. After the year 2000, removals will exceed growth for hardwoods. As removals exceed growth, the supply of timber declines. The trend of removals exceeding growth is projected not only for the country as a whole, but also for the region of the country including Illinois. At present Illinois is not a large timber-producing state. Approximately 11% of Illinois land is in forest, while the national average is 33% of all lands (1). For some Illinois counties in which strip mining is present, however, forests do cover a relatively large portion of the county. Examples are: Jackson — 34%, Williamson — 30%, Perry — 21%, and Saline — 20% coverage (23).

To the extent that consumers would be willing to reduce demand and accept fewer wood products there would be no problem as indicated above. Before allowing a decrease in the supply of wood to occur for any reason, however, one must be conscious of the products made from wood. The following listing for species found to have good growth on strip-mined land indicates the wide variety of wood products that would be affected by a reduction in timber supplies: furniture, interior trim,

cabinet work, veneer, paneling, gunstocks, caskets, lumber, containers, railroad ties, pulpwood, mine props, boxes, crates, barrels, fenceposts, flooring, agricultural implements, ships and boats, firewood, printers' blocks, patterns, tool handles, baseball bats, tennis rackets, golf club heads, billiard cues, shuttles, spools, bobbins, cigar boxes, musical instruments, fruit and berry boxes, toys, woodenware, novelties, venetian blinds, signs, and matches (53).

We recognize that mined lands are only a part of total timber resources. In addition, this discussion of timber products is not meant to imply that there would not also be some sacrifices if land were reclaimed to timber. To whatever extent replacement or increases in timber acreage could be made by use of mined land for forests, some decreases in livestock and crop production may result. The important fact in favor of properly reclaiming mined land for forests, however, is the gain of a high quality forestry site. The decrease in livestock and row crops on marginal quality farm land would be balanced against the increase in quality timber supply and the other tangible and intangible returns from forested land.

The above discussion indicates effects of a declining supply of timber. Another aspect of timber resources is that they are renewable. As our country and the world continue to exhaust the supplies of nonrenewable resources, efforts will have to be made to convert to other sources of raw materials for products. Where feasible, wood products will likely be substituted for other products.

This substitution would include use of renewable hardwood and softwood resources for nonrenewable steel, aluminum, oil, and coal. The demand for timber would increase. However, "A condition precedent to any major substitution requires reserves and potential for replenishment" (10). Before any substitution could take place, timber supplies must be adequate to meet the new demand as well as the demand for traditional wood products. When this demand is contrasted with the declining supply discussed earlier, a crisis situation in which the contribution of mined land reclaimed to timber can be measured does appear to be developing, especially when one considers the time period necessary to increase the supply of harvestable timber. Unless alternative uses for such land would clearly produce higher values, using them to expand the timber supply would appear to be a primary goal in reclamation.

Property Tax Revenues

Under new taxing policies, land purchased by a mining company is not reassessed to an industrial assessment until the mining permit has been filed. The industrial assessment remains in effect until reclamation has been completed. At that time, the land is then reassessed in accord with the reclaimed use.

Taxes on an acre of land vary from county to county, but row-crop land is assessed at a higher value than is pasture, and forest land is assessed lower than pasture. If land which had not been in timber prior to mining is reclaimed to forest, this results in a decline in tax revenue. As shown earlier, forest land in Illinois has been converted to pasture and row-crop uses as a result of mining for all years of record (Fig. 7 and 10).

Because of a potential reduction in tax revenue, county boards often oppose any plans to reclaim land to forest. In order for timber to be encouraged on suitable strip-mined land, this opposition must be overcome. From the standpoint of county tax revenues, homesites and industrial land uses will yield the highest

levels of tax revenue from strip-mined land. The location of the mined lands largely affects reclamation to these land uses. We considered earlier how these uses may be stimulated by reclamation to trees.

Solution to the Tax Squeeze

To overcome county board opposition will require changes in taxing policy. A tax policy change could be based on a reduction in reclamation costs by reclaiming to forest those lands best suited to forest. This would mean less grading and spoil handling. If the reclamation savings was $2000, then a split of perhaps two-thirds could be retained by the mining company and one-third paid by the mining company as a "tax" to the county to compensate for the reduction in tax revenue which would result from a forest assessment instead of row-crop assessment. Using the above figure of $2000, the county would get about $670 per acre.

This would be the equivalent of a great many years of tax based on dividing the $670 by the differential between taxes per acre for row crops versus forest. The single payment would be worth much more, because the annual interest alone would likely be substantially greater than the tax return. By using these or other tax policy alternatives, county board opposition to reclamation to timber could well be eliminated.

This discussion has shown that reclaiming some lands to forest may be good public policy and a good investment for a mining company. The initial savings in reclamation costs would make reclaiming to forest or pasture an optimal investment for land if the law permitted. The need for productive agricultural land to be reclaimed to food production, however, will affect which lands can best be reclaimed to timber. Dedicating land which is best suited for forest to tree growth would result in an increase in timber supply and other tangible and intangible forest resources for future years. From the viewpoints both of monetary returns and society's needs, many benefits can be gained by reclaiming strip-mined land to trees.

VII. Reclamation Legislation and Goals

Illinois Law

Illinois reclamation legislation would appear to encourage forestation as a reclamation alternative by its policy statement in the present law:

> It is declared to be the policy of this State to provide for conservation and reclamation of lands affected by surface mining in order to restore them to optimum future productive use and to provide for their return to productive use including but not limited to: the planting of forests; the seeding of grasses and legumes for grazing purposes; the planting of crops for harvest; the enhancement of wildlife and aquatic resources; the establishment of recreational, residential, and industrial sites; and for the conservation, development, management, and appropriate use of all the natural resources of such areas for compatible multiple purposes, to aid in maintaining or improving the tax base; and protecting the health, safety, and general welfare of the people, the natural beauty and aesthetic values, and enhancement of the environment in the affected areas of the State; to prevent erosion, stream pollution, water, air, and land pollution and other injurious effects to persons, property, wildlife and natural resources; and to assure that conservation and reclamation plans for all surface mining activity are available for the prior consideration of county governments within whose jurisdiction such lands will be affected by surface mining (45).

One notes that the planting of forests is listed before either pastures or crops. However, a closer review of present reclamation practices indicates a paradox: the discouragement of forest replacement is occurring.

Subsequent to 1962, Illinois has had a series of mining laws which have culminated in the present 1971 Surface-Mined Land Conservation and Reclamation Act together with the 1975 amendments. Table 7 summarizes the nature of these laws and the stages of development in regulation of reclamation activities.

The most important changes to note are grading restrictions, surface soil content, period of time allowed for reclamation, and classification of appropriate land use. Associated with each law is a set of rules and regulations that details how the act is to be administered. These rules and regulations are adopted by the Director of the Department of Mines and Minerals in compliance with each act. The 1975 amendments created a seven-person council which serves as an advisory body to the Director of the Department of Mines and Minerals. The Council's suggestions are not binding.

The reason for enactment of the 1975 amendments was "To lessen the impact of surface mining on our food-producing capacity and on the environment" (25). Sponsors of the amendments were primarily from agricultural areas of central and

Table 7. Summary of Illinois reclamation laws effective from 1962, 1968, 1971, and 1975.

TITLE	The Open Cut Land Reclamation Act and Amendments (OCLR)	The Surface-Mined Land Reclamation Act (SMLR)	The Surface-Mined Land Conservation and Reclamation Act (SML)	Same as 1971
HOUSE BILL NUMBER	306 and 582	462	1626	1277
EFFECTIVE DATES	1/1/62 and 7/1/63	7/1/68	7/1/71	7/1/75
IMPLEMENTING AGENCY	Department of Conservation	Department of Conservation	Department of Mines and Minerals	Department of Mines and Minerals
MINING PERMITS AND BONDING	Permit and bond required before mining. Bond $1000 plus $200 for each affected acre in excess of 5 acres included in permit	Permit and bond required before mining. Bond $3000 plus $600 for each affected acre in excess of 5 acres included in permit	Permit and bond required before mining Bond $600 for each acre to be affected	Permit and bond required before mining. Bond maximum $5000 for each acre to be affected
RECLAMATION PLANS	Submitted for land affected the previous yr. Blanket permits & substitution of previously mined land allowed	Same as 1962	Submitted and accepted to secure mining permit; plans made available to county boards	Submitted & accepted to secure permit. Submitted to county boards for comment 60 days before Department decision
LAND USE DECISION	Operator may determine if forests are to be hardwood and the land used for forest	Tree species and later use of forest to be determined by operator under Department advisement	If Director determines best use is row crops or row cropped within 5 yrs. prior to mining, land graded for same	If Director determines best use of land is for row crops, land graded for same (Rule 1104)

REQUIREMENTS FOR GRADING	Strike-off grading required next to public roads and cemeteries, minimum width 10' for ridges & 15' for peaks. Pasture must have a minimum 10' strike-off & crop land must be traversable with farm machinery	Grading to 30% slope within 660 feet of public roads, buildings, and cemeteries. Elsewhere minimum grading strike-off, 10' width for forest land, 18' for pasture. Crop land must be traversable with farm machinery	Maximum 15% graded slope for pasture and row crop; 30% for forest, wildlife and recreation	Same grading as 1971 or Rule 1104, approximate original contour, replacement of 4' rooting medium and 8-18" darkened surface soil. High walls reshaped to 50% original slope
REQUIREMENTS FOR TREE PLANTING	Forest land must be planted to 680 trees per acre. No sampling procedure specified. Fire lanes 10' in width, maximum spacing of 440 yards	500 trees per acre, 450 must survive second growing season. Sampling procedure specified. Fire lanes 25' in width with maximum spacing of 440 yds. Road grades no more than 20%	Same as 1968	Same as 1968
REQUIRMENTS FOR TOXIC SPOIL AREAS	No planting required on toxic spoil if site cannot be revegetated after 10 years of weathering	Reclamation period extended yr. by yr. After 8 yrs. Department may declare forfeiture of bond	All mined areas must be revegetated unless in 3 years they can weather naturally and support plant growth	No natural weathering allowed
REQUIREMENTS FOR ACID-FORMING	Acid-forming material covered by at least 2' of earth or spoil	Acid-forming material covered by 4' of water or other material and maximum slope of 30%	Same as 1968	Same as 1968
OTHER PERMITS, HAULAGE ROADS, ADVISORY COUNCIL		Refuse and gob pile permits required. Gob piles covered minimum 4' material, bordered by tree species that encourage vegetation	Abandoned haulage roads and drainage ditches removed and graded except if consistent with reclamation plan	Haulage roads same as 1971 Creation of Advisory Council

northern Illinois (42, 43), indicative of the lack of satisfaction by the agricultural community with prior reclamation laws.

Ever since the early days of strip mining in Illinois, competition for land between strip mining and agriculture has been apparent. The present reclamation law recognizes the state's need for the continuation of surface mining and also the need to prevent permanent alteration of row-crop land so that Illinois can continue to have high capability agricultural land and remain a leader in agricultural production.

The thrust of present legislation is to require grading of all strip-mined land and the restoration of darkened surface soil and rooting medium on land which was capable of row-crop production prior to mining based on the USDA Soil Conservation Service (SCS) soil classifications of the affected land prior to mining. In the presently active mining district of northwestern Illinois the amount of such farmland by county ranges from less than 25% to over 75%. Less is found in the southwestern and southern mining districts.

Permit Process

Under present rules and regulations, a mining company is required to secure a surface-mining permit before mining operations can begin. The application is accompanied by a bond of $600 to $5000 per acre, and by a filing fee of $50 plus $25 for every affected acre (41).

Figure 65. "It is declared to be the policy of this State to provide for conservation and reclamation of lands affected by surface mining in order to restore them to optimum future productive use and to provide for their return to productive use including but not limited to: the planting of forests: ...."

Information provided in the permit application includes a description of the conservation and reclamation plan for the affected area. Examples of other required items of information are: land and mineral rights ownership, the number of acres, the existing vegetation and wildlife on lands to be affected, current and past land uses, and information about water and drainage for the area.

At least 60 days prior to any action by the Department of Mines and Minerals, the reclamation plan is deposited with the respective county boards affected by the mining. If a county board desires to make recommendations to the Department of Mines and Minerals on the plan, the recommendations must be made within 45 days.

If requested by the county board, public hearings on the reclamation plan are then conducted by the Department of Mines and Minerals. At these hearings the county boards and public present their recommendations to the Department. County boards may receive advice on the plans from their Soil and Water Conservation Districts, which in turn receive input from the SCS.

The last step is for the Director of the Department of Mines and Minerals to decide whether the plan complies with reclamation laws and if the plan will accomplish all the reclamation required of the mining company. The mining company is then notified of the acceptance or rejection of its application and of recommended changes in the plan.

Potential for Tree Planting

The discouragement of forestation appears to enter at the stage of the permit process when county boards request that land be reclaimed for row-crop capability. This occurs even if a mining company does not intend to use the land for row crops or even if the land prior to mining was supporting uses other than row cropping. This is possible since the rules and regulations for the 1975 amendments state that the Director of the Department of Mines and Minerals determines whether land, according to the SCS soil classification, is capable of row-crop production and that the optimum future use is for row crops. Productivity measured by plant growth is not used as a criterion in the SCS soil classification. The identification of designated farm land is entirely related to soil characteristics and other physical criteria. The mining company is then required to prepare the site according to the grading and surface soil replacement provisions of Rule 1104 (41). The impact of Rule 1104 assumes greater importance if the possibilities of constituting improved soils through mining are negated by the surface-soil replacement requirements.

Use of the SCS soil classifications as the deciding factor for determining site preparation appears to circumvent other aspects of the permit process by negating consideration of "...the short and long term impact of the proposed mining on vegetation, wildlife, fish, land use, land values, local tax base, the economy of the region and the state, the employment opportunities, air pollution, water pollution, soil contamination, noise pollution, and drainage" (41). After lands are released from bond the operator may use them as he sees fit.

The present reclamation practices seem to promote a very few land uses rather than a wide variety. This raises questions about whether the land-use policy called for by the law is being fulfilled. A by-product of strip-mining now appears to be the conversion of land from forest. None of the laws or regulations express this conversion as an objective of mining reclamation.

Legal Issues

Only on rare occasions have the courts had an opportunity to interpret reclamation laws. One of the leading cases concerning reclamation was, however, decided by an Illinois court. Illinois earliest reclamation law, enacted in 1943 (44), was held unconstitutional in NORTHERN ILLINOIS COAL CORP. V. MEDILL (62). The analysis the court used in declaring the law to be unconstitutional can be summarized as follows:

1) The law could not be sustained as a measure to protect public health.

2) The court rejected the Department of Mines and Minerals assertion that the legislature could find the law to be a valid conservation measure because it required preservation of the chief economic value of the land by preservation of its capability for cultivation or "...making a choice between cultivated or 'row' crops and forestry". Instead the court held:

a) there was a lack of proof that restoring the land to its original contour would make the land suitable for row-crop cultivation and

b) the state could not compel a private landowner to convert his property to a higher land use at his own expense since that would be similar to confiscation of property.

3) Even if the law was valid as a health or conservation measure it would be invalid by reason of unreasonable discrimination against coal operators as distinguished from other mining operators.

From this holding, there are several implications for our present reclamation law:

1) The present law seeks to further the preservation of the economic value of land by preserving its capability for cultivation;

2) There should be proof that grading and surface soil replacement are needed to preserve economic value.

3) Compelling a private landowner to convert his property to a higher land use is similar to confiscation of property.

Figure 66. Strike-off grading next to public roads and cemeteries was required in the 1961 law. (Courtesy of USDA Forest Service)

The preservation of economic value of land would appear to be a valid concern for the legislature to have. However, another mining case, PEEVYHOUSE V. GARLAND COAL AND MINING CO. (63), suggests that expending large amounts of money to reclaim land which will only result in a slight increase of the actual value of the land is so grossly disproportionate that public policy will not allow the agreement to be enforced because of the economic waste which would result.

In PEEVYHOUSE a private landowner had contracted with a mining company to allow the mining company to strip mine his land. The agreement contained a clause requiring the mining company to perform certain reclamation work including the moving of many thousands of cubic yards of overburden. After completing its mining activities, the coal company refused to do the reclamation work, and the private landowner sued for damages. The court held the landowner could not recover the cost of $29,000 to perform the reclamation work. Instead it awarded damages of $300, the amount the farm land had actually diminished in value. The court refused to give the landowner the $29,000 because there was not enough economic benefit to be gained by reclaiming the land to justify the expense.

Under present reclamation law, the costs of required reclamation are passed on to the coal consumer through increased prices. Although public policy would seem to demand that mined land not be left barren, one may question whether the most expensive reclamation techniques, surface soil segregation and subsequent replacement, should be enforced if other reclamation techniques would suffice or be superior on a long-term basis.

As discussed in other sections of this bulletin, trees on mined land do have good growth under conditions other than those required in Rule 1104 for row crops; yet if a mining company desires to plant trees, in most cases the site would still have to be prepared according to row-crop standards. Thus, in some cases coal consumers may be charged the cost of unnecessary reclamation. The end of preserving the economic value of land by preserving its capability for cultivation may result in economic waste and not be in the public's best interest. For land marginally capable of producing row crops, reclamation according to row-crop standards may be considered unjustifiable.

Another implication for our present law from NORTHERN ILLINOIS COAL CO. was that there should be proof that reclamation practices do make the land suitable for cultivation. Over the next five years, studies conducted jointly by the University of Illinois and five Illinois coal companies and by Southern Illinois University and Sahara Coal Company will attempt to identify the best way to reclaim surface-mined land for agricultural and forestry uses and to assess the effectiveness of present reclamation practices.

The last legal issue is whether requiring a landowner to prepare for specified land uses violates a constitutional right of the prohibition of the taking of property. Courts have held that reasonable restraints on the use of property are allowable, provided the restraints are in the interest of the common good and bear a real and substantial relation to public health, safety, morals, and general welfare, MIDLAND COAL CORP. V. COUNTY OF KNOX (60).

Other states have found that reclamation laws requiring the placing of coarse materials on the bottom of the excavation, finer near the top, and then replacement of topsoil on these other materials to be constitutional by concluding that the preservation of the fertility of privately owned land is within the power of a state legislature, MERCED DREDGING CO. V. MERCED COUNTY (59).

One writer's analysis of the property confiscation issue is that: "Courts in various states have handed down widely varying rulings. The Supreme Court has been of little help in stemming the confusion — it has not taken a significant case in this area since 1928" (33).

The fifth amendment of the U. S. Constitution protects the right of private property by stating that private property shall not be taken for public use without just compensation. The questions raised by this issue include the following:

1) "When is property 'taken' by regulation — when the owner's exercise of full and complete dominion is restricted in any way, or limited severely, or when the land is completely removed from his control?

2) What is 'public use' — enjoyment, or absence of nuisance, or physical occupation?

3) What is 'just compensation' — does the securing of advantages to society as a whole and, therefore, to each individual and property owner, provide compensation which is just for some limitations on the use of land, or does any loss in value resulting from such limitations require monetary compensation?" (20).

These issues are relevant to many areas of governmental regulation dealing with land, not only reclamation of strip-mined land. To the extent these issues are still undecided, so too is the validity of Illinois reclamation law.

Recent Illinois reclamation legislation has been associated with a decrease in forestation as a reclamation alternative. Yet this effect, prior to this publication, has generally been unchallenged, even though some grounds do exist for a challenge:

1) the paradox existing between the policy statement of the law and the apparent effect of the law,

2) the court's interpretations of reclamation laws; it should be emphasized that NORTHERN ILLINOIS COAL CORP. has never been overruled; in fact, there has been a noticeable lack of challenges to subsequent reclamation laws, and

3) the U. S. Constitution may prohibit the specification of land uses to a mining company, a private landowner.

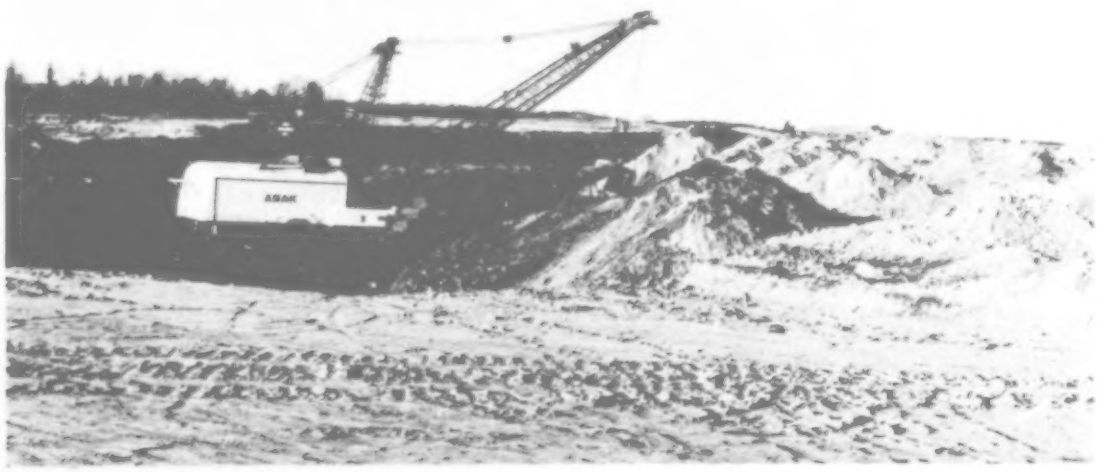


Figure 67. A mining permit with a reclamation plan and a bond must be secured before mining can begin.

This discussion was intended to raise some doubts as to the appropriateness of the present reclamation legislation. Each Illinois reclamation law has fostered a more uniform reclamation policy. They support reclamation to row crops rather than a policy which would focus on land uses most suitable for an individual mining site.

Reclamation Goals

We now know that reclamation to trees has benefitted Illinois for recreation, housing, education, wildlife, and other needs. Tree growth after 30 years promises a successful timber production program. High levels of environmental quality and beneficial soil development are promoted by reclamation to trees. Forested lands, and abandoned farmlands, are particularly suitable for forestation after mining.

Tree planting is an integral part of multipurpose land-use planning. In all parts of Illinois trees and shrubs have a place around lakes as border plantings, on areas too small for efficient use of farm equipment, and as border plantings.

A clear mandate of reclamation legislation is to re-establish vegetation. The choice of type of vegetation should be matched to the resource potential or site quality of each mined area. The concept of matching resources and reclamation also depends on the needs or demands for a healthy balance of land in trees, pasture, row crops, or lakes within each district. In the appropriate locations strip mines are an important resource for these needs. We have noted that in Will and Grundy counties surface-mined lands have absorbed expanding industrial, residential, and recreational development, providing a buffer against the loss of the most productive farm land.

Various interests have been heard in the arena of public debate on strip-mine reclamation. Because mined areas are predominantly rural, rural interests appear to have prevailed in mandating not only reclamation procedures but also reclamation goals. The city dweller and townsperson have a stake in our reclamation future. We hope this bulletin will lead to more active participation and interest by all citizens in defining and implementing reclamation goals. Our present laws may be unduly restrictive for promoting the best land use of our mined land resources.

The eve of an even newer reclamation program appears to be an excellent time for reflecting on the effects of past reclamation legislation and attempting to develop a more balanced land-use policy. We urge continuing recognition of the many benefits to be secured by reclaiming land to plantings of trees and to forests.

Figure 68. Reclamation to trees has provided excellent sites for recreation, housing, education, and wildlife. Tree planting offers important benefits for our reclamation future.

VIII. References

1. American Forest Institute. 1976. Forest facts and figures. Washington, D.C. 14 p.
2. Anonymous. 1977. Researchers seek ways to grow corn after coal. Farm Journal 101(9):D-1
3. Arkansas Department of Commerce, Forestry Commission. 1972. Forestry: its economic and environmental importance to Arkansas. 18 p.
4. Arnold, C.Y. and T.Kurtz. 1946. Photometer method for determining available phosphorus in soils. University of Illinois Department of Agronomy and Horticulture AG 1306:1-5.
5. Ashby, W.C. 1964. Vegetation development on a strip-mined area in southern Illinois. Transactions of the Illinois State Academy of Science 57:78-83.
6. Ashby, W.C., M.B.Baker,Jr., and J.B.Casteel. 1966. Forest cover changes in strip-mine plantations. Tree Planters' Notes 76:17-20.
7. Ashby, W.C. and M.B.Baker, Jr. 1968. Soil nutrients and tree growth under black locust and shortleaf pine overstories in strip-mine plantings. Journal of Forestry 66: 67-71.
8. Ashby, W.C. and C.A.Kolar. 1977. A 30-year record of tree growth in strip-mine plantings. Tree Planters' Notes 28:18-21, 31.
9. Beazley, R. and D.Spencer. 1976. The economic and geographic effects of the Shawnee National Forest on the county economies and the region of Southern Illinois. Unpublished research report USDA Forest Service Project Agreement No. 13-464. 81 p.
10. Bethel, J.S. and G.F.Schrueder. 1976. Forest resources: an overview, p. 153-158. In P.H.Abelson and A.L.Hammond, (ed.), Materials: renewable and nonrenewable resources. American Association for the Advancement of Science, Washington, D.C.
11. Boyce, S.G. and D.J.Neebe. 1959. Trees for planting on strip-mined land in Illinois. USDA Forest Service, Central States Forest Experiment Station Technical Paper 164. 33 p.
12. Bray, R.H. 1942. Directions for modified test for replaceable potassium in soils. University of Illinois Department of Agronomy AG 1033:1-4.
13. Callahan, J.C. and J.G.Callahan. 1971. Effects of strip mining and technological change on communities and natural resources in Indiana's coal mining region. Purdue University Agricultural Experiment Station Research Bulletin No. 871. 43 p.
14. Callahan, J.C. and R.P.Smith. 1974. An economic analysis of black walnut plantation enterprises. Purdue University Agricultural Experiment Station Research Bulletin No. 912. 20 p.
15. Casey, L.R., P.L.Roth, and H.W.Fox. 1975. Forest planting practices for Illinois: recommended by Illinois Technical Forestry Association. Illinois Department of Conservation. 40 p.
16. Caspall, F.C., A.R.Longwell, and M.A.Yergler. 1974. Surface mining for coal: a regional report. Western Illinois Regional Council, Macomb. 74 p.

17. Chapman, A.G. 1967. How strip-land grading affects tree survival and growth. Southern Illinois University School of Agriculture Publication No. 29. 34 p.
18. Clawson, M. 1964. Man and land in the United States. University of Nebraska Press, Lincoln. 178 p.
19. Clawson, M. 1975. Forests for whom and for what? Johns Hopkins University Press, Baltimore. 175 p.
20. Council of State Governments. 1975. State alternatives for planning and management: a task report. Lexington, Kentucky.
21. Curtis V., ed. 1974. Illinois outdoor recreation. Illinois Department of Conservation. 155 p.
22. Doll, E.C. and R.E.Lucas. 1973. Testing soils for potassium, calcium, and magnesium, p. 133-152. In J.D.Beaton and L.M.Walsh, (ed.), Soil testing and plant analysis. Soil Science Society of America, Madison, Wisconsin.
    Potassium was determined on the Bray-1 extract with flame emission on a Perkin-Elmer Atomic Absorption spectrophotometer.
23. Essex, B.L. and D.A.Gansner. 1965. Illinois' timber resource. USDA Forest Service Research Bulletin LS-3. 56 p.
24. Evans, R.J. and J.R.Bitler. 1975. Coal surface mining reclamation 1975 costs. USDI Loose leaf. 11 p.
25. Fehrenbacher, J.B., I.J.Jansen, and S.R.Aldrich. 1977. Reclaiming surface-mined soils: completed and proposed studies. Illinois Research 19(2): 8-9.
26. Filer, E.E. 1977. Personal communication. Supervisor, Land Reclamation Division, Illinois Department of Mines and Minerals, Springfield.
27. Finn, R.E. 1953. Foliar nitrogen and growth of certain mixed and pure forest plantings. Journal of Forestry 51: 31-33.
28. Grandt, A.F. and A.L.Lang. 1958. Reclaiming Illinois strip coal land with legumes and grasses. Illinois Agricultural Experiment Station Bulletin No. 628. 64 p.
29. Greater Egypt Regional Planning Commission. 1963. Preliminary report. Carbondale, Illinois. 188 p.
30. Greater Egypt Regional Planning and Development Commission. 1967. Overall economic development program. Carbondale, Illinois. 201 p.
31. Hayes, W.R. 1977. Personal communication. President, Hayes Fair Acres, DuQuoin, Illinois.
32. Haynes, R.J. and W.D.Klimstra. 1975. Illinois lands surface-mined for coal. Cooperative Wildlife Research Laboratory, Southern Illinois University. 201 p.
33. Healy, R.G. 1976. Land use and the states. Johns Hopkins University Press. Baltimore. 233 p.
34. Hoover, W.L. 1977. Walnut timber as an investment. Walnut Council Member Newsletter 4(3): 3-5.
35. Illinois Department of Conservation. 1963-1968. Open cut land reclamation. Annual reports for 1962-1967.
36. Illinois Department of Conservation. 1969-1971. Surface-mined land reclamation. Annual reports for 1968-1970.
37. Illinois Department of Conservation. 1975. Pyramid State Park. Pamphlet 25M-5-75. n.p,
38. Illinois Department of Conservation. 1976. Banner: a marshland legacy. Pamphlet 10M-6-76. n.p.

39. Illinois Department of Conservation. 1978. In nature, movement is the rule. Outdoor Highlights 6(2):5-8.
40. Illinois Department of Mines and Minerals. 1972-1977. Surface-mined land conservation and reclamation. Annual reports for 1971-1976.
41. Illinois Department of Mines and Minerals. 1976. Rules and regulations: surface-mined land conservation and reclamation act. 50 p.
42. Illinois 78th General Assembly. 1974. Illinois blue book. 875 p.
43. Illinois 78th General Assembly. 1974. Legislative synopsis and digest, vol. I. 992 p.
44. Illinois Revised Statutes. 1943. Chapter 93, 162.
45. Illinois Revised Statutes. 1975. Chapter 93, 202.
46. Illinois State Geological Survey. 1976. Fossil peat from the Illinois Basin. Education Series No. 11. n.p.
47. Johnson, S. 1974. Recent sociological contributions to water resource management and development, p. 164-199. In L.D.James, (ed.), Man and water: the social sciences in management of water resources. University of Kentucky Press, Lexington.
48. Jones, G.S. 1967. Vertebrate ecology of a strip-mined area in southern Indiana. M.S.Thesis, Purdue University. 158 p.
49. Karr, J.R. 1968. Habitat and avian diversity on strip-mined land in east-central Illinois. Condor 70(4):348-357.
50. Klimstra, W.D. 1962. Wildlife management and recreation on strip-mined areas. Outdoor Illinois 1(2):14-18.
51. Knudsen, D. 1975. Recommended phosphorus soil tests, p. 16-19. In North Dakota Agricultural Experiment Station, Recommended chemical soil test procedures for the North Central Region. Bulletin No. 499.
    Phosphorus was determined with a Spectronic 20 colorimeter using the ascorbic acid method and the Bray-1 acidified ammonium flouride extractant.
52. Kolar, C. and W.C.Ashby. 1978. Potential for woodland habitat from surface-mine tree plantings. Transactions of the Forty-third North American Wildlife and Natural Resources Conference. In press.
53. Lewey, H.J. 1975. Trees of the north central states. USDA Forest Service General Technical Report NC-12. 11 p.
54. Limstrom, G.A. 1960. Forestation of strip-mined land in the central states. USDA Forest Service, Agriculture Handbook No. 166. 74 p.
55. Limstrom, G.A. and G.H.Deitschman. 1951. Reclaiming Illinois strip coal lands by forest planting. University of Illinois Agricultural Experiment Station Bulletin 547. 50 p.
56. Lindstrom, D.E. 1960. Rural social change: a textbook in rural sociology. Stipes Publishing Co., Champaign, Illinois. 265 p.
57. Little, C.E. 1969. Challenge of the land. Pergamon Press, New York. 151 p.
58. Meigs, W.B., A.N.Mosich, C.E.Johnson, and T.F.Keller. 1974. Intermediate accounting. McGraw-Hill Book Co., New York. 1081 p.
59. Merced Dredging Co. v. Merced County. 1946. 67 F. Supp. 598 (D.C. Cal.)
60. Midland Coal Corp. v. County of Knox. 1953. 1 Ill. 2d 191
61. Murphy, C.E.,Jr., T.R.Sinclair, and K.R.Knoerr. 1977. An assessment of the use of forests as sinks for the removal of atmospheric sulfur dioxide. Journal of Environmental Quality. 6:388-396.
62. Northern Illinois Coal Corp. v. Medill. 1947. 397 Ill. 98

63. Peevyhouse v. Garland Coal and Mining Co. 1962. 382 P.2d 109 (Okl.)
64. Pohlmann, V.C. and D.V.Taylor. 1973. Central Illinois planning data analysis. Illinois State University Press, Normal. 202 p.
65. Richardson, E.S. 1968. Jellyfish in them thar hills. Field Museum of Natural History Bulletin 10(39):4-9.
66. Riley, C.V. 1954. The utilization of reclaimed coal striplands for the production of wildlife. Transactions of the North American Wildlife Conference 19:324-327.
67. Roseberry, J.L. 1963. Report on a survey of potential recreational utilization of Illinois strip-mined lands. Midwest Coal Producer's Institute, Inc., Springfield, Illinois. 11 p.
68. Schavilje, J.P. 1941. Reclaiming Illinois strip-mined coal lands with trees. Journal of Forestry 39:714-719.
69. Scott, J.T.,Jr. and G.F.Summers. 1974. Problems in rural communities after industry arrives, p. 94-107. In L.R. Whiting, (ed.), Rural industrialization: problems and potentials. Iowa State University Press, Ames.
70. Seastrom, P.A. 1963. United Electric Coal Company's land use program. Mining Congress Journal 49(12):26-28, 33.
71. Southwestern Illinois Metropolitan Area Planning Commission. 1965. An inventory and analysis of existing data, characteristics, and facilities in the Illinois portion of the St.Louis metropolitan area. Collinsville. 2 v.
72. Southwestern Illinois Metropolitan and Regional Planning Commission. 1977. Development policies background data. Collinsville. 234 p.
73. Stoddard, C.H. 1961. The small private forest in the United States. Resources for the Future, Inc., Washington, D.C. 171 p.
74. Urbanek, R. 1976. Vertebrate and floral diversity on strip-mined land in Williamson and Saline counties, Illinois. M.A. Thesis. Southern Illinois University. 146 p.
75. U. S. Department of Agriculture. Forest Service. 1973. National forest landscape management volume 1. Agriculture Handbook No. 434. 77 p.
76. U. S. Department of Agriculture. Forest Service. 1973. The outlook for timber in the United States. Forest Resource Report No. 20. 367 p.
77. U. S. Department of Interior. Bureau of Outdoor Recreation. 1973. Proceedings of regional conference on reclamation of surface-mined land for outdoor recreation. 72 p.
78. U. S. Department of Interior. Bureau of Outdoor Recreation. 1975. Sources of assistance in reclaiming surface-mined lands for outdoor recreation. 72 p.
79. Weber, L.S. 1977. Personal communication. President, Coal Producers Association of Illinois, Springfield, Illinois.
80. Yeager, L.E. 1941. Wildlife management on coal stripped land. Transactions of the North American Wildlife Conference 5:348-353.

IX. Reclamation Directory

I. Mining industry

A. Coal industry associations

1. Coal Producers Association of Illinois
   Louis S. Weber, President
   314 E. Adams Street
   Springfield, Ill. 62701 (217) 528-3401
2. Illinois Coal Operators Association
   Joseph Spivey, President
   Suite 220, Reisch Bldg.
   117 S. 5th Street
   Springfield, Ill. 62701 (217) 528-2092

B. Reclamation personnel for surface mining operations in Illinois

1. AMAX Coal Co.
   Harry D. Yocum Director of Environmental Engineering
   105 S. Meridian
   Indianapolis, Ind. 46225 (317) 266-2885
2. Big Ridge Coal Co.
   214 Washington
   Carterville, Ill. 62918
3. Brown Brothers Excavating Co.
   P. O. Box 288
   Harrisburg, Ill. 62946
4. Consolidation Coal Co.
   Earl Smith, Regional Environmental Supervisor
   101 Plaza East Blvd.
   Evansville, Ind. (812) 479-8911
5. Freeman United Coal Mining Co.
   John Roll, P. E.
   Reclamation Supervisor
   Box 570
   Canton, Ill. 61520 (309) 647-0855
6. Midland Coal Co.
   Philip Christy, Reclamation Director
   P. O. Box 8
   Trivoli, Ill. 61569 (309) 568-2121
7. Peabody Coal Co.
   Alten F. Grandt, Director of Reclamation
   301 N. Memorial Drive
   P. O. Box 235
   St. Louis, Mo. 63166 (314) 342-3619
8. Robertson & Associates, Inc.
   Bell Rive, Ill. 62810

9. Sahara Coal Co., Inc.
   Erich Egli, Chief Engineer
   Vine & Walnut Street
   Harrisburg, Ill. 62946 (618) 253-7121
10. Southwestern Illinois Coal Corp.
   Division of Arch Mineral Corporation
   Robert W. Holloway, Manager — Land Resources
   R. R. 1
   Percy, Ill. 62272 (618) 497-2141

II. State Agencies
   A. Department of Mines and Minerals
      1. Land Reclamation Division
         E.E. Filer, Supervisor
         704 State Office Bldg.
         400 Spring Street
         Springfield, Ill. 62706 (217) 782-4970
      2. Reclamation Technicians
         a. J. Donovan Larson
            1640 N. 20th
            Springfield, Ill. 62702 (217) 528-6913
         b. Charles Medvick
            1206 S. Duncan
            Marion, Ill. 62959 (618) 933-5450
         c. Marvin Utsinger
            R. R. 1
            Kingston, Ill. 60145 (815) 784-3456
         d. Douglas Downing
            R. R. 4, Box 232
            Marion, Ill. 62959 (618) 964-1604
         e. Ernest Ashby
            Box 1247, 405 Harrison Street
            Pawnee, Ill. 62558 (217) 625-7972
         f. Andrew Gilmore
            R. R. 2, Box 85
            Carlyle, Ill. 62231 (618) 594-4411
         g. Larry Damrau
            510 E. Farnham
            Princeton, Ill. 61356 (618) 875-3153
         h. Dean Spindler
            R. R. 1, Box 269-J
            Illiopolis, Ill. 62539 (217) 486-6437
         i. Willis Gale, Jr.
            Box 237
            Cuba, Ill. 61427 (309) 785-2571
      3. Abandoned Mined Lands Reclamation Council
         Allen Grosboll, Executive Director
         704 State Office Bldg.
         400 Spring Street
         Springfield, Ill. 62707 (217) 782-6791

B. Department of Conservation

1. Division of Forestry
   Allan Mickelson, State Forester
   R. R. 5, State Fair Grounds
   Springfield, Ill. 62707 (217) 782-2361
2. State tree nurseries
   a. Union State Tree Nursery
      Melvin Gerardo
      R. R. 1, Box 182
      Jonesboro, Ill. 62952 (618) 833-6125
   b. Mason State Tree Nursery
      Hugh B. Wycoff
      R. R. 1, Box 71
      Topeka, Ill. 61567 (309) 595-2185
3. District Foresters
   a. Will, Grundy, Kankakee counties
      Elmer Werhane
      P. O. Box 472
      Morton Arboretum
      Lisle, Ill. 60532 (312) 964-8081
   b. Henry, Knox, Mercer counties
      Matt Siemert
      P. O. Box 126
      301 East North Street
      Cambridge, Ill. 61238 (309) 937-2122
   c. Bureau, LaSalle, Stark counties
      John Benner
      P. O. Box 236
      909 North Main
      Princeton, Ill. 61356 (815) 875-3125
   d. Fulton county
      Reuben Laverdiere
      P. O. Box 335
      W. Jackson Road (Hwy. 136)
      Macomb, Ill. 61455 (309) 837-1124
   e. Peoria county
      Pete Skuba
      P. O. Box 795
      133 Parkway Drive
      Pekin, Ill. 61554 (309) 347-5119
   f. Schuyler county
      Grant Haley
      P. O. Box 401
      720 S. 10th Street
      Havana, Ill. 62644 (309) 543-3401
   g. Livingston county
      Dale Donahoo
      P. O. Box 361
      Hidden Springs State Forest
      Shelbyville, Ill. 62565 (217) 644-2411

h. Edgar, Vermilion counties
Robert Blair
P. O. Box 129
Rt. 16 & Harrison St. Rd.
Charleston, Ill. 61920 (217) 345-2420

i. Greene county
Dan Schmoker
34 W. Broadway
Department of Conservation
Alton, Ill. 62002 (618) 462-1181

j. Adams, Brown, Hancock counties
Curt Bobsin
P. O. Box 244
211 South Madison
Pittsfield, Ill. 62363 (217) 285-2221

k. Randolph, St.Clair counties
Tom Seals
P. O. Box 21
1 mile E. on Rt. 154
Sparta, Ill. 62286 (618) 443-2925

l. Madison county
John Hicks
P. O. Box 149
Eldon Hazlet State Park
Carlyle, Ill. 62231 (618) 594-4475

m. Wabash county
Bill Keyth
P. O. Box 313
200-½ North Walnut
Olney, Ill. 62450 (618) 393-6732

n. Jefferson county
Gary Stratton
P. O. Box 206
1404 West Main
Fairfield, Ill. 62837 (618) 847-3781

o. Jackson, Perry counties
Glenn Campbell
P. O. Box 188
14 North 11th Street
Murphysboro, Ill. 62966 (618) 687-2622

p. Gallatin, Hardin, Pope, Saline counties
Richard Heavener
P. O. Box F
202 S. Granger Street
Harrisburg, Ill. 62946 (618) 253-7966

q. Johnson county
David Gillespie
P. O. Box 351
Ferne Clyffe State Park
Anna, Ill. 62906 (618) 995-2568

4. Division of Wildlife
   Jack Ellis, Director
   605 State Office Building
   Springfield, Ill. 62706 (217) 782-6302
5. District Wildlife Managers
   a. Grundy, Kankakee, Will counties
      Thomas Kwak
      Des Plaines Conservation Area
      R. R. 3, Box 167
      Wilmington, Ill. 60481 (815) 476-7622
   b. Bureau, LaSalle, Peoria, Stark counties
      Max Runkle
      133 Parkway
      Pekin, Ill. 61554 (309) 347-5119
   c. Fulton, Henry, Knox, Mercer counties
      Robert Williamson
      Room 10, National Bank Building
      Monmouth, Ill. 61462 (309) 734-2887
   d. Adams, Brown, Hancock, Schuyler counties
      William Allen
      Siloam Springs State Park
      R. R. 1
      Clayton, Ill. 62364 (217) 894-6205
   e. Greene, Madison counties
      David Harper
      34 W. Broadway
      Alton, Ill. 62002 (618) 462-1181
   f. Randolph, St.Clair counties
      William Boyd
      R. R. 2 Route 154 East
      Sparta, Ill. 62286 (618) 443-2925
   g. Livingston, Vermilion counties
      John Cole
      313 N. Lawrence
      Gibson City, Ill. 60936 (217) 784-4730
   h. Edgar county
      Robert Cottingham
      Route 16 & Harrison St. Rd.
      Charleston, Ill. 61920 (217) 345-2420
   i. Wabash county
      John Slachter
      301 Jones Street
      Sumner, Ill. 62466 (618) 936-2149
   j. Jackson, Jefferson, Perry, Williamson counties
      Bill Mestel
      Mt. Vernon Game Farm
      R. R. 5
      Mt.Vernon, Ill. 62861 (618) 242-0830

k. Gallatin, Hardin, Johnson, Pope, Saline counties
Jerard Garber
Union County Refuge
R. R. 2
Jonesboro, Ill. 62952 (618) 833-5175

C. Agricultural Extension Service
Theodore W. Curtin
219 Mumford Hall
University of Illinois
Urbana, Ill. 61801 (217) 333-2777

D. Illinois Institute for Environmental Quality
Environmental Information Center
309 West Washington Street
Chicago, Ill. 60606 (312) 793-3870

E. Illinois Environmental Protection Agency
2200 Churchill Road (Main office)
Springfield, Ill. 62706 (217) 782-2000

F. Illinois Pollution Control Board
309 West Washington Street
Chicago, Ill. 60606 (312) 793-3620

G. Illinois State Geological Survey
121 Natural Resources Building
Urbana, Ill. 61801 (217) 344-1481

III. Universities and Colleges

A. Various universities and colleges throughout Illinois have consulting services available in forestry and reclamation matters. Contact the one nearest to you.

B. Southern Illinois University
Coal Extraction and Utilization Research Center
Lyle V. A. Sendlein, Director
Southern Illinois University
Carbondale, Ill. 62901 (618) 453-5105

IV. Federal Agencies

A. U. S. Department of the Interior
Bureau of Mines
Thomas O. Glover, State Liaison Officer
120 Jefferson West I - 525 West Jefferson St.
Springfield, Ill. 62702 (217) 525-4368

B. U. S. Department of Agriculture

1. Forest Service
North Central Forest Experiment Station
Forestry Sciences Laboratory
Southern Illinois University
Carbondale, Ill. 62901 (618) 453-2318

2. Soil Conservation Service - Initial contact with the SCS should originate with the District Conservationist for the appropriate county.

Daniel E. Holmes, State Conservationist (217) 356-3785,
Rex J. Hamilton, Biologist (217) 356-3787, and
Donald L. Howerton, Forester (217) 356-3787
200 W. Church Street
P. O. Box 678
Champaign, Ill. 61820
Richard R. Brown, Plant Materials Specialist
555 Vandiver Drive
Columbia, Mo. 65201 (314) 276-3161

X. Common and Scientific Names of Plants

Common name	Scientific name
Alder, European (black)	Alnus glutinosa
Apple	Malus spp.
Ash, green	Fraxinus pennsylvanica var. subintegerrima
white	F. americana
Autumn olive	Elaeagnus umbellata
Basswood, American (Linden)	Tilia americana
Beech, American	Fagus grandifolia
Black walnut	Juglans nigra
Box elder (Ash-leaved maple)	Acer negundo
Brier, green	Smilax spp.
Buckthorn, common	Rhamnus cathartica
Butternut	Juglans cinerea
Catalpa, western	Catalpa speciosa
Cherry, choke	Prunus virginiana
wild black	P. serotina
Cottonwood	Populus deltoides
Dogwood	Cornus spp.
Elderberry	Sambucus canadensis
Elm, American	Ulmus americana
Gooseberry	Ribes spp.
Grape, wild	Vitis spp.
Hackberry	Celtis occidentalis
Hawthorn	Crataegus spp.
Hazelnut	Corylus americana
Hickory, shagbark	Carya ovata
Holly, deciduous	Ilex decidua
Honeysuckle, bush	Diervilla lonicera
Japanese	Lonicera japonica
Kentucky coffee tree	Gymnocladus dioicus
Larch, European	Larix decidua
Locust, black	Robinia pseudoacacia
honey	Gleditsia triacanthos

Maple, red	Acer rubrum
silver (soft)	A. saccharinum
sugar	A. saccharum
Mulberry (red or some white)	Morus rubra or alba
Oak, black	Quercus velutina
blackjack	Q. marilandica
bur	Q. macrocarpa
chestnut	Q. prinus
pin	Q. palustris
red (northern red)	Q. rubra
shingle	Q. imbricaria
southern red (Spanish)	Q. falcata
white	Q. alba
Osage orange	Maclura pomifera
Pecan	Carya illinoensis
Persimmon	Diospyros virginiana
Pine, Austrian	Pinus nigra
jack	P. banksiana
loblolly	P. taeda
oriental	P. sp.
pitch	P. rigida
ponderosa (western yellow)	P. ponderosa
red (Norway)	P. resinosa
Scotch	P. sylvestris
shortleaf	P. echinata
Virginia	P. virginiana
white	P. strobus
Plum	Prunus spp.
Poison ivy	Rhus radicans
Privet, swamp	Forestiera acuminata
Red cedar (eastern)	Juniperus virginiana
Redbud	Cercis canadensis
River birch	Betula nigra
Rose, multiflora	Rosa multiflora
Sassafras	Sassafras albidum
Siberian pea	Caragana arborescens
Sugarberry	Celtis laevigata
Sumac	Rhus spp.
Sweet (red) gum	Liquidambar styraciflua
Sycamore	Platanus occidentalis
Tree-of-heaven	Ailanthus altissima
Tulip tree (yellow poplar)	Liriodendron tulipifera
Willow, black	Salix nigra